

Pressley, Miriam

From: Bastek, Brian
Sent: Thursday, July 30, 2015 9:01 AM
To: O'Connor, David A.
Subject: Grenada VI Study Work Plan

Hi Dave.

I wanted to follow up with you regarding the work plan. It would technically be due in on Saturday, but I'm assuming I would receive it on Monday, August 3rd? Let me know how things are progressing. Thanks.

Brian Bastek
Environmental Engineer
U.S. EPA, Region 4
RCRA Corrective Action and Permitting Section
Resource Conservation and Restoration Division
61 Forsyth Street, SW
Atlanta, GA 30303
404-562-8511
bastek.brian@epa.gov

Pressley, Miriam

From: Bastek, Brian
Sent: Thursday, July 23, 2015 9:24 AM
To: Hodoh, Ofia
Subject: RE: FW: Grenada Manufacturing, LLC VI Work Plan
Attachments: Boring Locations.jpg; June 2015 Well Location Map.pdf; Plume Figure - Fourth Quarter 2014 GW Report.pdf

Please see attached. Thanks.

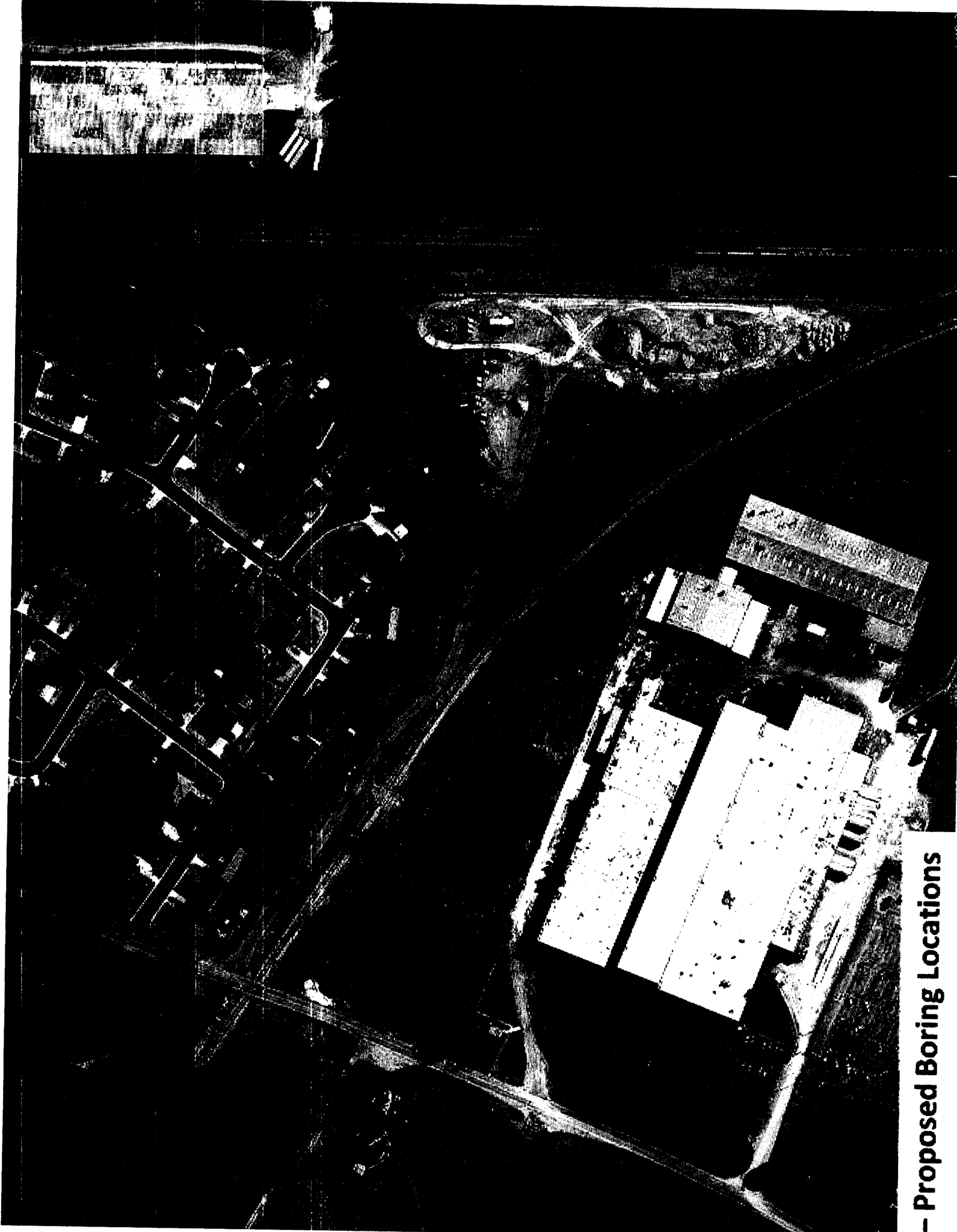
Brian Bastek
Environmental Engineer
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RCRA Corrective Action and Permitting Section
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Atlanta, GA 30303
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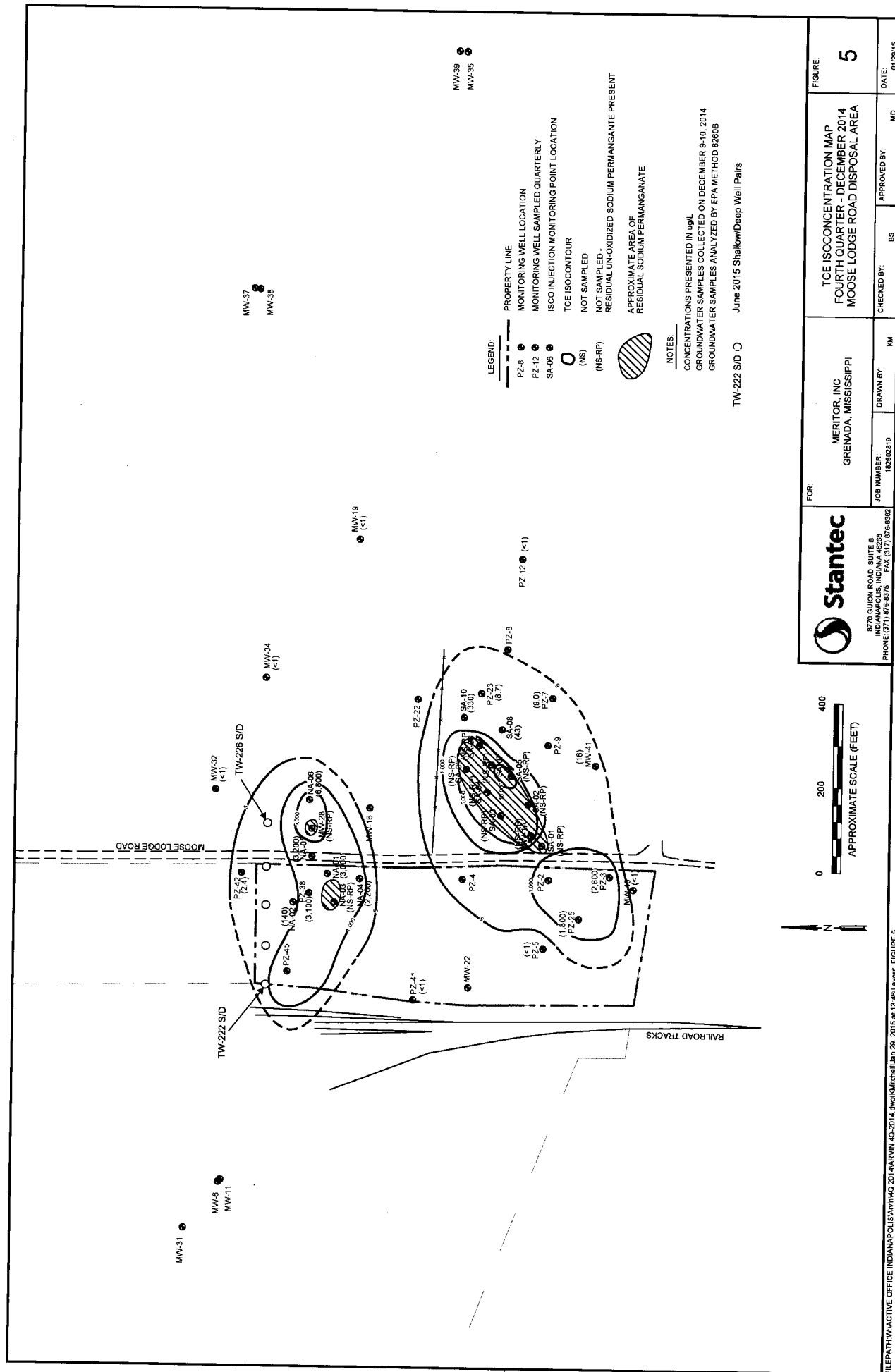
-----Original Appointment-----

From: Hodoh, Ofia
Sent: Tuesday, July 21, 2015 1:34 PM
To: Bastek, Brian
Subject: Accepted: FW: Grenada Manufacturing, LLC VI Work Plan
When: Thursday, July 23, 2015 9:30 AM-10:30 AM (UTC-05:00) Eastern Time (US & Canada).
Where: R4-10T7-Branch-Conf-Rm/Sam-Nunn-Federal-Building-ATL

I can be reached at 678.361.3041

— Proposed Boring Locations





Pressley, Miriam

From: Bastek, Brian
Sent: Monday, July 20, 2015 10:46 AM
To: O'Connor, David A.
Subject: RE: Moose Lodge Road Area

Can you talk before 1:30pm today?

Brian Bastek
Environmental Engineer
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RCRA Corrective Action and Permitting Section
Resource Conservation and Restoration Division
61 Forsyth Street, SW
Atlanta, GA 30303
404-562-8511
bastek.brian@epa.gov

From: O'Connor, David A. [<mailto:David.OConnor@Meritor.com>]
Sent: Friday, July 17, 2015 9:22 AM
To: Bastek, Brian
Subject: RE: Moose Lodge Road Area

I will call you Monday Brian.

MERITOR

David A. O'Connor
Corporate Environmental Manager
Treasury Department
248.435.2706 tel
248.435.8354 fax
(b) (6)
david.oconnor@meritor.com

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www.meritor.com

From: Bastek, Brian [<mailto:Bastek.Brian@epa.gov>]
Sent: Friday, July 17, 2015 9:21 AM
To: O'Connor, David A.
Subject: RE: Moose Lodge Road Area

Thanks Dave. Let's talk more Monday when you are back from vacation. It would be good to see more of these type of figures.

Brian Bastek
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bastek.brian@epa.gov

From: O'Connor, David A. [<mailto:David.OConnor@Meritor.com>]
Sent: Tuesday, July 14, 2015 2:50 PM
To: Bastek, Brian
Cc: Anderson, Meredith
Subject: FW: Moose Lodge Road Area

Brian:

Please see below. Attached also are 2 figures for perspective of sampling completed last week of the new wells east of the RR tracks..

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From: James Peeples [<mailto:JPeebles@tandmassociates.com>]
Sent: Tuesday, July 14, 2015 1:06 PM
To: Jimmy Crellin (jimmy_crellin@deq.state.ms.us)
Cc: O'Connor, David A.
Subject: Moose Lodge Road Area

Jimmy,

We are done with the well installations and sampling at the Moose Lodge Road Area (MLRA). I do not have enough confidence in the GC results at this time to provide those, but we will have laboratory analytical results soon and can share that information. In terms of a tool to tell us what compounds were present and their relative concentration, I think it was good and we do have both TCE and cis-1,2-DCE in groundwater beneath the Intermediate Clay. We will need to get the laboratory results before I am confident in the actual concentrations.

Thanks,



JAMES PEEPLES, PE

VICE PRESIDENT, SENIOR TECHNICAL ENVIRONMENTAL ENGINEER

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Pressley, Miriam

From: Bastek, Brian
Sent: Friday, July 17, 2015 10:18 AM
To: O'Connor, David A.
Subject: RE: Moose Lodge Road Area

OK. I'm at home on Mondays and Wednesdays so dial my cell: (b)(6)

Thanks.

Brian Bastek
Environmental Engineer
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Pressley, Miriam

From: Bastek, Brian
Sent: Monday, July 13, 2015 5:59 PM
To: O'Connor, David A.
Subject: RE: Example QAAPs for vapor Intrusion

1 pm is good for me. Thanks for being flexible.

Brian Bastek
Environmental Engineer
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RCRA Corrective Action and Permitting Section
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404-562-8511
bastek.brian@epa.gov

From: O'Connor, David A. [mailto:David.OConnor@Meritor.com]
Sent: Monday, July 13, 2015 4:07 PM
To: Bastek, Brian
Subject: RE: Example QAAPs for vapor Intrusion

How does 1:00PM look for you?

MERITOR

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david.oconnor@meritor.com

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Troy, Michigan 48084
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www.meritor.com

From: Bastek, Brian [mailto:Bastek.Brian@epa.gov]
Sent: Monday, July 13, 2015 3:15 PM
To: O'Connor, David A.
Subject: RE: Example QAAPs for vapor Intrusion

Sorry Dave, I forgot I have training tomorrow in the morning. Can you do sometime in the afternoon?

Brian Bastek
Environmental Engineer
U.S. EPA, Region 4
RCRA Corrective Action and Permitting Section
Resource Conservation and Restoration Division

61 Forsyth Street, SW
Atlanta, GA 30303
404-562-8511
bastek.brian@epa.gov

From: O'Connor, David A. [<mailto:David.OConnor@Meritor.com>]
Sent: Monday, July 13, 2015 2:32 PM
To: Bastek, Brian
Subject: RE: Example QAAPs for vapor Intrusion

How about tomorrow morning 9am EST?

Sent with Good (www.good.com)

From: Bastek, Brian <Bastek.Brian@epa.gov>
Sent: Monday, July 13, 2015 2:30:32 PM
To: O'Connor, David A.
Subject: RE: Example QAAPs for vapor Intrusion

Hi Dave. When can we talk this week about Grenada?

Brian Bastek
Environmental Engineer
U.S. EPA, Region 4
RCRA Corrective Action and Permitting Section
Resource Conservation and Restoration Division
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404-562-8511
bastek.brian@epa.gov

From: O'Connor, David A. [<mailto:David.OConnor@Meritor.com>]
Sent: Friday, July 10, 2015 3:32 PM
To: Bastek, Brian
Subject: RE: Example QAAPs for vapor Intrusion

Don got it on July 2nd and emailed it to me the same day.

Dave

Sent with Good (www.good.com)

From: Bastek, Brian <Bastek.Brian@epa.gov>
Sent: Friday, July 10, 2015 2:54:39 PM
To: O'Connor, David A.
Subject: RE: Example QAAPs for vapor Intrusion

Dave,

Can you confirm receipt of the letter that went to Grenada Manufacturing, LLC? Did Don Williams pass that on to your folks?

Thanks.

Brian Bastek
Environmental Engineer
U.S. EPA, Region 4
RCRA Corrective Action and Permitting Section
Resource Conservation and Restoration Division
61 Forsyth Street, SW
Atlanta, GA 30303
404-562-8511
bastek.brian@epa.gov

From: O'Connor, David A. [<mailto:David.OConnor@Meritor.com>]
Sent: Tuesday, July 07, 2015 3:37 PM
To: Bastek, Brian
Subject: RE: Example QAAPs for vapor Intrusion

Thanks Brian. How about if we talk next week. I am working on a couple of critical projects that I have to complete this week before leaving on vacation. I'll be in FL all next week visiting my parents so I'll have the whole week open to talk any time that works for you.

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From: Bastek, Brian [<mailto:Bastek.Brian@epa.gov>]
Sent: Tuesday, July 07, 2015 3:26 PM
To: O'Connor, David A.
Subject: FW: Example QAAPs for vapor Intrusion

FYI

Let's talk about the work plan this week if you have some time. A second email will follow with another example QAPP.

Brian Bastek
Environmental Engineer
U.S. EPA, Region 4
RCRA Corrective Action and Permitting Section
Resource Conservation and Restoration Division
61 Forsyth Street, SW

Atlanta, GA 30303
404-562-8511
bastek.brian@epa.gov

From: Bentkowski, Ben
Sent: Monday, June 29, 2015 10:38 AM
To: Bastek, Brian; Anderson, Meredith
Subject: Example QAAPs for vapor Intrusion

Brian and Meredith,
Here are the two QAAPs for work that was performed by EPA at the Former Macon Naval Ordnance Plant. They are pretty lean documents with many of the actual procedures referenced but not included. It should give the consultant a good example to use for crafting the specific document for Granada Mfg. As I mentioned last Friday, the evaluation of the analytical results for the risk and follow on actions is nearly complete, per Glenn Adams. Glenn or I will forward it to you as soon as he's done. With that submittal I think we should layout our expectations about what we would expect to see in the reporting of the data.

I'll also, today, look over what Brian H. sent over on Friday about community involvement plan.

I'll be out July 3-8, by the way, exploring the geology of the New York Finger Lakes region.

Thanks,
Ben

Ben Bentkowski, P.G.
USEPA R4 Superfund Scientific Support Section
61 Forsyth St
ATL,GA 30303
(404) 562-8507 o
(770) 296-2529 c

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61 Forsyth Street, SW
Atlanta, GA 30303
404-562-8511
bastek.brian@epa.gov

From: Bentkowski, Ben
Sent: Monday, June 29, 2015 10:38 AM
To: Bastek, Brian; Anderson, Meredith
Subject: Example QAAPs for vapor Intrusion

Brian and Meredith,
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I'll also, today, look over what Brian H. sent over on Friday about community involvement plan.

I'll be out July 3-8, by the way, exploring the geology of the New York Finger Lakes region.

Thanks,
Ben

Ben Bentkowski, P.G.
USEPA R4 Superfund Scientific Support Section
61 Forsyth St
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(404) 562-8507 o
(770) 296-2529 c

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Pressley, Miriam

From: Bastek, Brian
Sent: Thursday, July 9, 2015 9:11 AM
To: Norman, Michael; Anderson, Meredith
Subject: Grenada 16th Section Landfill
Attachments: Grenada (16th Section).pptx

Non Responsive

Brian Bastek
Environmental Engineer
U.S. EPA, Region 4
RCRA Corrective Action and Permitting Section
Resource Conservation and Restoration Division
61 Forsyth Street, SW
Atlanta, GA 30303
404-562-8511
bastek.brian@epa.gov

From: O'Connor, David A. [<mailto:David.OConnor@Meritor.com>]
Sent: Wednesday, July 08, 2015 4:46 PM
To: Bastek, Brian
Subject: RE: Example QAAPs for vapor Intrusion

Brian:

The landfill is off Highway 333 – see attached. Hopes this helps.

MERITOR

David A. O'Connor
Corporate Environmental Manager
Treasury Department
248.435.2706 tel
248.435.8354 fax
(b) (6)
david.oconnor@meritor.com

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2135 West Maple Road, B-146A
Troy, Michigan 48084
USA
www.meritor.com

From: Bastek, Brian [<mailto:Bastek.Brian@epa.gov>]
Sent: Wednesday, July 08, 2015 3:23 PM
To: O'Connor, David A.
Subject: RE: Example QAAPs for vapor Intrusion

Thanks Dave. Where is this 16th section landfill? Do you have an address?

Brian Bastek
Environmental Engineer

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RCRA Corrective Action and Permitting Section
Resource Conservation and Restoration Division
61 Forsyth Street, SW
Atlanta, GA 30303
404-562-8511
bastek.brian@epa.gov

From: O'Connor, David A. [<mailto:David.OConnor@Meritor.com>]
Sent: Wednesday, July 08, 2015 2:10 PM
To: Bastek, Brian
Subject: RE: Example QAAPs for vapor Intrusion

Brian:

Jimmy Crellin is his name. The other site is 16th Section Landfill.

MERITOR

David A. O'Connor
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From: Bastek, Brian [<mailto:Bastek.Brian@epa.gov>]
Sent: Wednesday, July 08, 2015 12:28 PM
To: O'Connor, David A.
Subject: RE: Example QAAPs for vapor Intrusion

Dave,

Who's the guy from MDEQ that you work with on the Moose Lodge property and the 5 mile landfill? Is that the other parcel name, the 5 mile landfill?

Thanks.

Brian Bastek
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Site Locations



I-55

16th
Section

Grenada
Airport

Grenada
Manufacturing

Moose
Lodge
Road

Grenada, MS

2 Miles

16th Section Property



16th Section Property

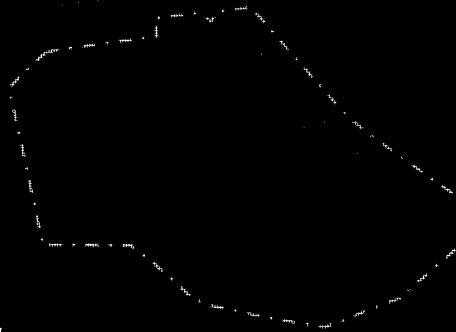
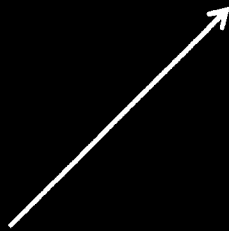


900 feet

16th Section Plume



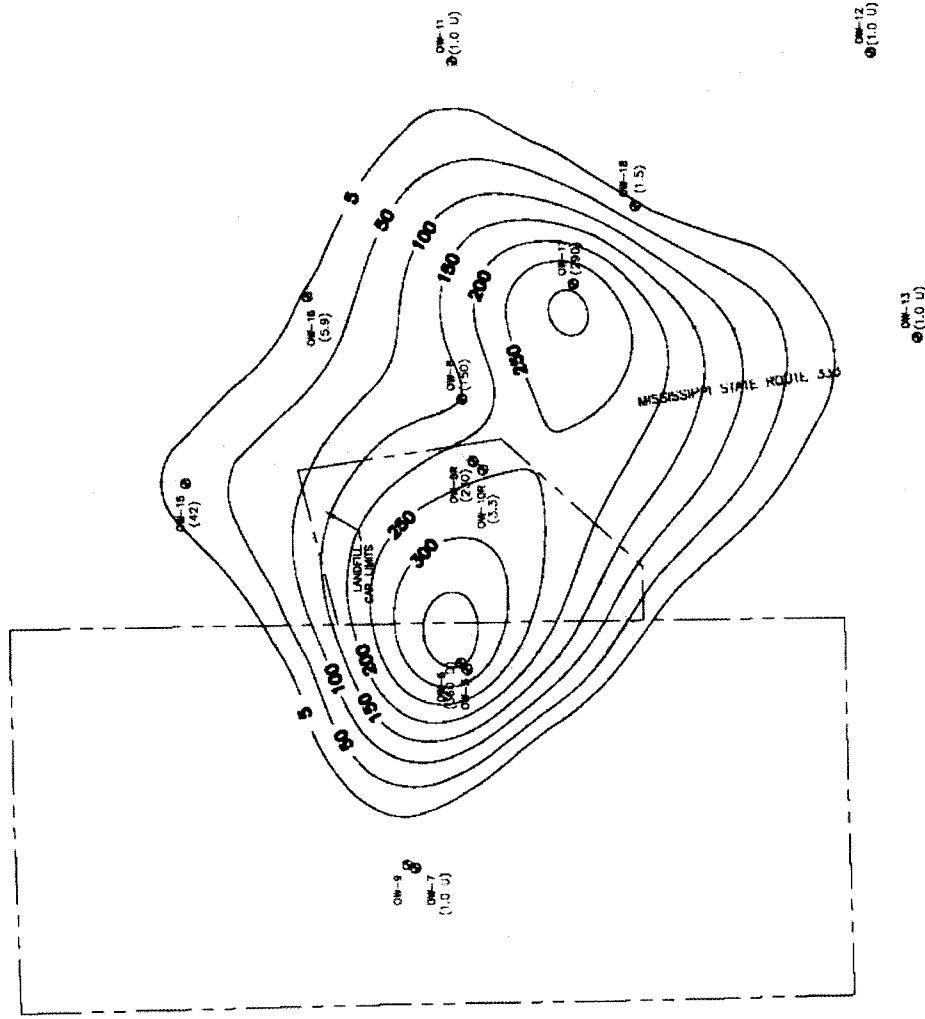
Groundwater
Flow



900 feet



Plume Detail - 16th Section Property



Pressley, Miriam

From: Bastek, Brian
Sent: Thursday, July 9, 2015 8:55 AM
To: O'Connor, David A.
Subject: RE: Example QAAPs for vapor Intrusion

Yes, thank you.

Brian Bastek
Environmental Engineer
U.S. EPA, Region 4
RCRA Corrective Action and Permitting Section
Resource Conservation and Restoration Division
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404-562-8511
bastek.brian@epa.gov

From: O'Connor, David A. [<mailto:David.OConnor@Meritor.com>]
Sent: Tuesday, July 07, 2015 3:37 PM

To: Bastek, Brian
Subject: RE: Example QAAPs for vapor Intrusion

Thanks Brian. How about if we talk next week. I am working on a couple of critical projects that I have to complete this week before leaving on vacation. I'll be in FL all next week visiting my parents so I'll have the whole week open to talk any time that works for you.

MERITOR

David A. O'Connor
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(b) (6)
david.oconnor@meritor.com

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Troy, Michigan 48084
USA
www.meritor.com

From: Bastek, Brian [<mailto:Bastek.Brian@epa.gov>]
Sent: Tuesday, July 07, 2015 3:26 PM
To: O'Connor, David A.
Subject: FW: Example QAAPs for vapor Intrusion

FYI

Let's talk about the work plan this week if you have some time. A second email will follow with another example QAPP.

Brian Bastek
Environmental Engineer
U.S. EPA, Region 4
RCRA Corrective Action and Permitting Section
Resource Conservation and Restoration Division
61 Forsyth Street, SW
Atlanta, GA 30303
404-562-8511
bastek.brian@epa.gov

From: Bentkowski, Ben
Sent: Monday, June 29, 2015 10:38 AM
To: Bastek, Brian; Anderson, Meredith
Subject: Example QAAPs for vapor Intrusion

Brian and Meredith,

Here are the two QAAPs for work that was performed by EPA at the Former Macon Naval Ordnance Plant. They are pretty lean documents with many of the actual procedures referenced but not included. It should give the consultant a good example to use for crafting the specific document for Granada Mfg. As I mentioned last Friday, the evaluation of the analytical results for the risk and follow on actions is nearly complete, per Glenn Adams. Glenn or I will forward it to you as soon as he's done. With that submittal I think we should layout our expectations about what we would expect to see in the reporting of the data.

I'll also, today, look over what Brian H. sent over on Friday about community involvement plan.

I'll be out July 3-8, by the way, exploring the geology of the New York Finger Lakes region.

Thanks,
Ben

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Pressley, Miriam

From: Bastek, Brian
Sent: Tuesday, July 7, 2015 3:26 PM
To: O'Connor, David A.
Subject: FW: Example QAAPs for vapor Intrusion
Attachments: QAPP April 2015 VI Sampling.pdf

Second one.

Brian Bastek
Environmental Engineer
U.S. EPA, Region 4
RCRA Corrective Action and Permitting Section
Resource Conservation and Restoration Division
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**UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 4**


Science and Ecosystem Support Division
Enforcement and Investigations Branch
980 College Station Road
Athens, Georgia 30605-2720


April 16, 2015

4SESD-EIB

MEMORANDUM

SUBJECT: Macon Naval Ordnance Plant Vapor Intrusion Study Revisit
Macon, Georgia
SESD Project No. 15-0295

FROM: Landon Pruitt, Environmental Engineer 
Superfund and Air Section

THRU: Kevin Simmons, Acting Chief 
Superfund and Air Section

TO: Brian Farrier, Remedial Project Manager
Superfund Division

Attached is the Quality Assurance Project Plan (QAPP) for the vapor intrusion study to be conducted at the Macon Naval Ordnance Plant site, in Macon, GA. The investigation is scheduled for the week of April 20th, 2015. If you have any questions or comments please contact me at 706-355-8620 or pruitt.landon@epa.gov.

Attachment



Quality Assurance Project Plan
U.S. Environmental Protection Agency
 Science and Ecosystem Support Division
 980 College Station Road
 Athens, GA 30605

SESD Project ID No.: 15-0295
 SESD Category 2 QAPP

SECTION A: Project Planning Elements			
A1. Title (Project Name):	Macon Naval Ordnance Plant Vapor Intrusion Study Revisit		
Project Location:	Allied Industrial Park 660 Allied Industrial Blvd Macon, Bibb County, Georgia		
Project Requestor and Organization:	Brian Farrier, Remedial Project Manager Superfund Division Atlanta Federal Center 61 Forsyth Street S.W. Atlanta, GA 30303		
Project Leader's Name, Position and Organization:	Landon Pruitt, Environmental Engineer Superfund and Air Section, Field Services Branch, SESD		
Project Leader's Signature:		Date: 4/16/2015	
Technical Reviewer's Name and Position:	Tim Slagle, Regional Expert Superfund and Air Section, Field Services Branch, SESD		
Technical Reviewer's Signature:		Date: 4/16/2015	
Section Chief's Name and Position:	Kevin Simmons, Acting Chief Superfund and Air Section, Field Services Branch, SESD		
Section Chief's Signature:		Date: 4/16/2015	
A2. Table of Contents			
SECTION A:	Project Planning Elements	Pages	1-3
SECTION B:	Data Generation and Acquisition	Pages	4-6
SECTION C:	Assessment/Oversight	Page	7
SECTION D:	Data Validation and Usability	Page	7
REFERENCES:	Listed References	Page	8
FIGURE 1:	MNOP Vapor Intrusion Study Map	Page	9
TABLE 1	Sample Information	Page	4
TABLE 2	SESD VOC Target Analytes	Page	10-12



Quality Assurance Project Plan
U.S. Environmental Protection Agency
 Science and Ecosystem Support Division
 980 College Station Road
 Athens, GA 30605

SESD Project ID No.: 15-0295
 SESD Category 2 QAPP

A3. Distribution List	Brian Farrier, RPM	
A4. Project Personnel	Organization	Responsibilities
Landon Pruitt	SESD, FSB, Superfund and Air Section	Project Leader / Sampler/Sample Processor
Tim Slagle	SESD, FSB, Superfund and Air Section	Sampler / Safety Officer
Comments: Personnel that have not been deemed competent and/or proficient under SESD's ISO-17025 accreditation in the areas where they will be working will be teamed with SESD personnel (Tim Slagle) who are competent and proficient in conducting these air sampling and field measurement activities.		
A5. Problem Definition (Investigation Objectives and Background Information):		
Site Background: The study will be conducted at the former Macon Naval Ordnance Plant, specifically at the four buildings located at 660 Allied Industrial Blvd. in Macon, Bibb County, Georgia (Figure 1). Refer to the previous QAPP, <i>Macon Naval Ordnance Plant Vapor Intrusion Study - QAPP</i> , February 2015, for further site background information. This investigation is in response to a previous field investigation performed by SESD (15-0162) during the week of February 23 rd . Results from that investigation showed elevated levels of trichloroethene (TCE), as well as TCE breakdown products cis-1,2 dichloroethene (DCE) and vinyl chloride (VC) in sub-slab soil gas samples as well as one indoor air sample. After being informed of the results from the February 2015 study, the tenants used their in-place HVAC systems to increase the air exchange rate of the break room in the Line 7 Building where the elevated concentrations in indoor air were detected. The previous study was conducted in winter so the HVAC units were operating on a relatively low air exchange needed for temperature management.		
A6. Project Description:		
For this investigation, SESD will re-sample the indoor air location with elevated concentrations of TCE, cis-1,2 DCE, and VC from the previous sampling event. Sampling this station again will determine the effectiveness of the remediation system implemented by the tenant. Two samples will be collected, one each for two consecutive 24 hour intervals at the same location, to examine any time variance of the station. The results will be used by SESD to assemble a sampling memo (project does not constitute a full final report) that will be forwarded to Brian Farrier, Remedial Project Manager RPM, Superfund Division, US EPA. Also during this deployment, SESD will dispose of the groundwater IDW that was generated and left on-		



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SESD Project ID No.: 15-0295
 SESD Category 2 QAPP

site, with the permission of the site tenant, during the previous investigation (SESD 15-0162). SESD will take the drum to Rocky Creek Water Reclamation Facility, roughly a mile SE of the site, and pump the water into their system.	
Applicable regulatory information, actions levels, etc.	The data generated by this study will be evaluated by EPA Region 4. Generally, an acute screening level analysis will be conducted using the best available health screening benchmarks.
Decision(s) to be made based on data:	The results of this sampling investigation will assist in determining the effectiveness of the exhaust system changes made by the tenants of the building in question
Field Study Date:	April 20, 2015
Projected Lab Completion Date:	35 days after the Lab's receipt of the samples.
Final Report Completion Date:	SESD will provide a memo reporting findings within 30 days after receipt of all analytical data. Results that are considered immediate action response levels will be reported to the RPM immediately as provisional data under SESD standards of procedure.

A7. Quality Objectives and Criteria All samples/sample locations meet the field investigation objectives and purposes summarized in Sections A5 and A6 of this QAPP.
A8. Special Training/Certifications <ul style="list-style-type: none"> • OSHA 40hr Personnel Protection Safety • 8-Hr safety Refresher • CPR/First Aid Proficiency/Competency for all sampling and associated procedures listed in Section B2 (Exception: If working with another proficient/competent field team member, this requirement is waived.)
A9. Documents and Records The final report will be prepared in accordance with the requirements of the SESD <i>Operating Procedure for Report Preparation and Distribution</i> , SESDPROC-003-R5. All field observations, measurements and sampling activities supporting the field investigation will be recorded and documented according to the SESD <i>Operating Procedure for Logbooks</i> , SESDPROC-010-R5. Project files will be maintained according to the SESD <i>Operating Procedure for Control of Records</i> , SESDPROC-002-R6.



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SECTION B: Data Generation and Acquisition

B1. Sampling Design

The sampling design was chosen based on the data quality objectives of the study.

Media	Number of Samples	Analyses
Indoor Air	2	Scan, VOCs

B2. Sampling Methods, General Procedures

The following SESD field measurement and sampling procedures will be followed during this field study, as applicable:

SEDDPROC-307-R3 Soil Gas Sampling
 SEDDPROC-110-R3 Global Positioning System
 SEDDPROC-205-R2 Field Equipment Cleaning and Decontamination
 SEDDPROC-202-R3 Management of Investigation Derived Waste

SAMPLING PROCEDURE:

SESD will collect two 24-hour indoor air samples using 6 liter passivated sampling canisters. These samples will be collected back to back at the same sampling station. All sampling and QA/QC procedures for field activities will be conducted in accordance with the EPA Region 4 SESD Field Branches Quality Systems and Technical Procedures. Sample custody will be maintained by SESD for transport to the SESD laboratory for analysis. Station and sample names can be seen in Table 1 below.

Analysis of the samples will be conducted by the SESD laboratory in accordance with *EPA Compendium Method TO-15, Determination Of Volatile Organic Compounds (VOCs) In Air Collected In Specially-Prepared Canisters and Analyzed by Gas Chromatography/Mass Spectrometry (GC/MS)*, January 1999. Laboratory QA/QC procedures will be conducted in accordance with the guidelines incorporated in the analytical methods.

The number of sampling locations are to be based on access permission and discussion between property occupants, the RPM, and SESD sampling personnel. Access to the properties to be sampled will be obtained by Brian Farrier, RPM, US EPA.

TABLE 1 Sample Information

Station ID	Sample ID	Location	
MNOP20	MNOP20IA042015	Line 7 Building Break Room	Indoor Air Sample, Day 1
MNOP20	MNOP20IA042115B		Indoor Air Sample, Day2
#R4DART#	MNOPTA0415	-	Trip Blank Air



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SESD Project ID No.: 15-0295
SESD Category 2 QAPP

B3. Sampling Handling and Custody

All samples will be handled and custody maintained according to the following:

SESD Analytical Support Branch Laboratory Operations and Quality Assurance Manual,
April 2015 Version.
SESD Operating Procedure for Sample and Evidence Management, SESDPROC-005-R2.
*SESD Operating Procedure for Packing, Labeling and Shipping of Environmental and Waste
Samples*, SESDPROC-209-R3.

B4. Analytical Methods

SESD:

The air samples will be analyzed using *EPA Compendium Method TO-15, Determination Of Volatile Organic Compounds (VOCs) In Air Collected In Specially-Prepared Canisters and Analyzed by Gas Chromatography/Mass Spectrometry (GC/MS)*, January 1999. The EPA Method TO-15 VOC Target Analytes are listed along with Minimum Detection Limits (MDLs) in Table 2. Although no groundwater sampling or analyses will occur during this investigation, the list of groundwater target analytes were included in Table 2 for reference and results comparisons to previous or future investigations.

Several of the VOC Target Analytes can be analyzed by ASB for in either groundwater or soil gas but not in both. These VOCs are noted and highlighted in yellow in Table 2 at the end of this plan. This is due to the differences in commercial blends of VOC standards used during the analyses of groundwater vs soil gas VOCs. If an analyte is found in one matrix but not analyzed/reported in the other matrix, that analyte can be reviewed in the missing matrix as a post process review if it is an analyte of concern. The results for this analyte can be reviewed again and possibly reported as a Tentatively Identified Compound (TIC). TICs will be flagged data for presumptive presence and estimated values.

CLP:

N/A

Other:

N/A

B5. Quality Control

Field:

Field quality control measure will be in accordance with the *SESD Operating Procedure for Field Sampling Quality Control*, SESD PROC-011-R4.

One air canister trip blank will be transported to the field, but not exposed, to check the possibility of contamination of the samples during transport and storage.



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Laboratory:	Specific laboratory quality control measures are specified in the <i>SESD Analytical Support Branch Laboratory Operations and Quality Assurance Manual</i> , April 2015.
B6. Instrument/Equipment Testing, Inspection and Maintenance All field measurement instruments and equipment will be maintained in accordance with the <i>SESD Operating Procedure for Equipment Inventory and Management</i> , SESDPROC-108-R4.	
B7. Instrument/Equipment Calibration and Frequency All field measurement instruments and equipment are calibrated according to the <i>SESD Operating Procedure for Equipment Inventory and Management</i> , SESDPROC-108-R4 and according to specific procedures included within the defined operating procedures for each instrument (see specific field measurement procedures in Section B2 of this QAPP).	
B8. Inspection/Acceptance for Supplies and Consumables All critical supplies and consumables for this field investigation are inspected and maintained in accordance with the following procedures: <i>SESD Operating Procedure for Purchasing of Services and Supplies</i> , SESDPROC-015-R4. <i>SESD Operating Procedure for Equipment Inventory and Management</i> , SESDPROC-108-R4. <i>SESD Operating Procedure for Field Sampling Quality Control</i> , SESDPROC-011-R4. The SESD Field Quality Manager and the Branch Quality Assurance Officers are responsible for ensuring that these requirements are met.	
B9. Non-direct Measurements: N/A	
B10. Data Management The field project leader will be responsible for ensuring that all requirements for data management are met. All data generated for this field investigation, whether hand-recorded or obtained using an electronic data logger will be recorded, stored and managed according to the following procedures: <i>SESD Operating Procedure for Control of Records</i> , SESDPROC-002-R6. <i>SESD Operating Procedures for Logbooks</i> , SESDPROC-010-R5.	



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SECTION C: Assessment/Oversight

C1. Assessments and Response Actions

Assessments will be conducted during the field investigation according to the *SESD Operating Procedure for Project Planning*, SEDSPROC-016-R3, to ensure the QAPP is being implemented as approved. The Project Leader is responsible for all corrective actions while in the field.

C2. Reports to Management

The Project Leader will be responsible for notifying the Project Manager (Requestor) and appropriate SESD management if any circumstances arise during the field investigation that may adversely impact the quality of the data collected.

SECTION D: Data Validation and Usability

D1. Data Review, Verification, and Validation

All analytical data will be provided by the SESD Analytical Support Branch and reviewed, verified and validated in accordance with the *SESD Analytical Support Branch Laboratory Operations and Quality Assurance Manual*, April 2015.

All data derived from SESD field measurements will be reviewed, verified, and validated in accordance with the *SESD Operating Procedure for Report Preparation and Distribution*, SEDSPROC-003-R5.

D2. Verification and Validation Methods

All analytical data will be provided by the SESD Analytical Support Branch and reviewed, verified and validated in accordance with the *SESD Analytical Support Branch Laboratory Operations and Quality Assurance Manual*, April 2015.

All data derived from SESD field measurements will be reviewed, verified, and validated in accordance with the *SESD Operating Procedure for Report Preparation and Distribution*, SEDSPROC-003-R5.

D3. Reconciliation with User Requirements

The usability of all data derived from SESD field sampling and measurements conducted during this field investigation will be evaluated in accordance with the *SESD Operating Procedure for Report Preparation and Distribution*, SEDSPROC-003-R5.

****Footnotes:** This Quality Assurance Project Plan (QAPP) has been prepared and approved according to the EPA *Requirements for Quality Assurance Project Plans (EPA QA/R5 EPA/240/B-01/003)*, U.S. Environmental Protection Agency, Office of Environmental Information, Washington, DC, March 2001(USEPA, 2001). This document will be used to ensure that the environmental data collected for this project are of the type and quality for the intended purposes. **This document is for SESD use only.**



Quality Assurance Project Plan
U.S. Environmental Protection Agency
Science and Ecosystem Support Division
980 College Station Road
Athens, GA 30605

SESD Project ID No.: 15-0295
SESD Category 2 QAPP

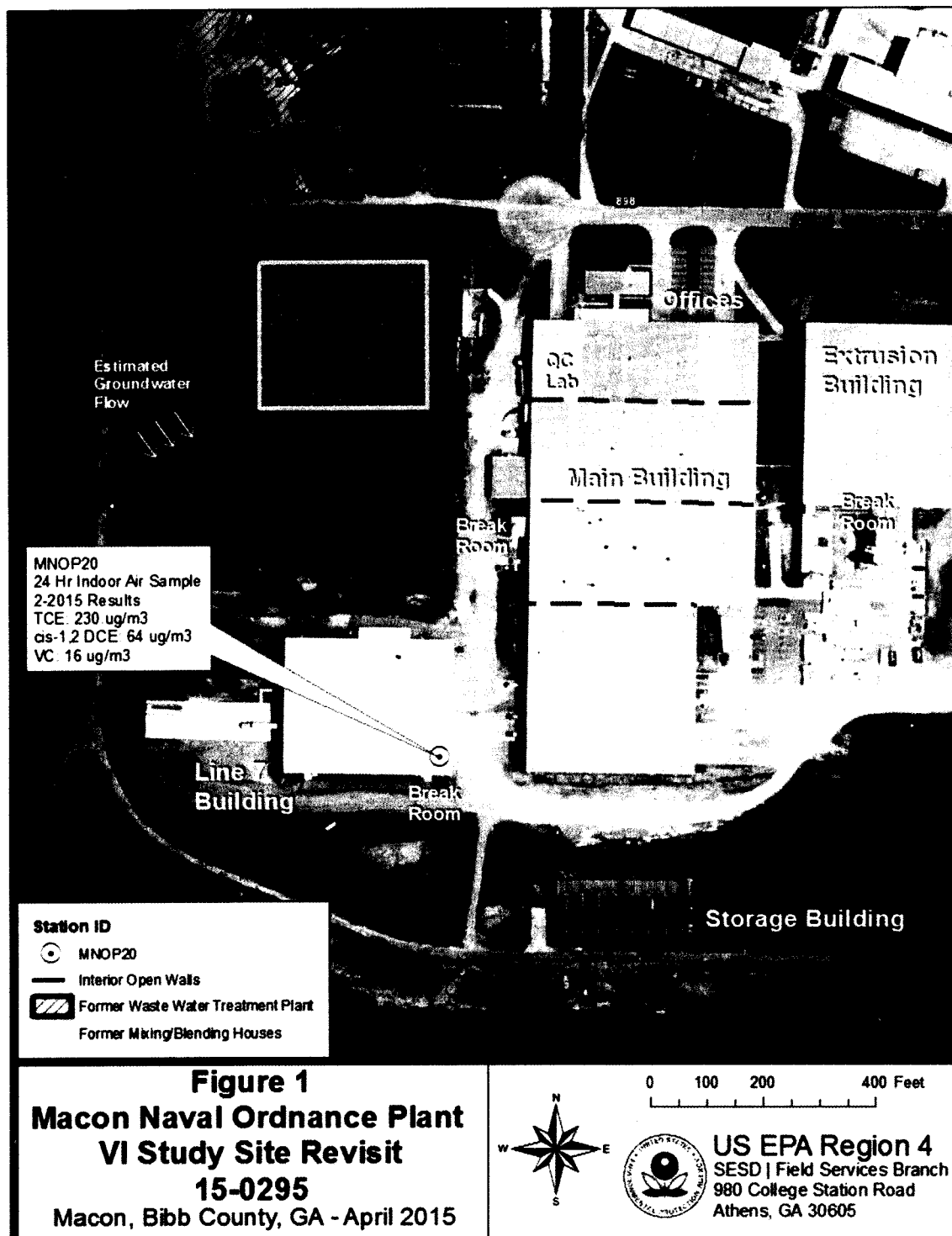
References:

1. Tetra Tech, *Final Expanded Site Inspection Report, Allied Industrial Park*, September 2009.
2. USEPA Region 4 SEDS Field Services Branch. *Macon Naval Ordnance Plant Vapor Intrusion Study – Quality Assurance Project Plan*, February 2015
3. USEPA Region 4 SEDS Field Services Branch. *Macon Naval Ordnance Plant Vapor Intrusion Study – Final Report*, April 2015
4. USEPA Region 4 SEDS ASB. *SESD Analytical Support Branch Laboratory Operations and Quality Assurance Manual*, April 2015.
5. USEPA. *EPA Compendium Method TO-15, Determination Of Volatile Organic Compounds (VOCs) In Air Collected In Specially-Prepared Canisters and Analyzed by Gas Chromatography/Mass Spectrometry (GC/MS)*, January 1999.
6. EPA Region 4 SEDS. *Field Branches Quality System and Technical Procedures (Latest Versions)*. <http://www.epa.gov/region4/sesd/fbqstp/>. Webpage last updated April 13, 2015.



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TABLE 2 - SESD VOC Target Analytes (1 of 3)

Analyte	Groundwater			Soil Gas		
	MDL	Units	Specific Method	MDL	Units	Specific Method
(m- and/or p-)Xylene	0.21	ug/L	EPA 8260C	0.19	ug/m3	EPA TO-15
1,1,1,2-Tetrachloroethane	0.19	ug/L	EPA 8260C	Not Analyzed for Soil Gas		
1,1,1-Trichloroethane	0.13	ug/L	EPA 8260C	0.13	ug/m3	EPA TO-15
1,1,2,2-Tetrachloroethane	0.16	ug/L	EPA 8260C	0.15	ug/m3	EPA TO-15
1,1,2-Trichloro-1,2,2-Trifluoroethane (Freon 113)	0.26	ug/L	EPA 8260C	0.15	ug/m3	EPA TO-15
1,1,2-Trichloroethane	0.18	ug/L	EPA 8260C	0.12	ug/m3	EPA TO-15
1,1-Dichloroethane	0.13	ug/L	EPA 8260C	0.082	ug/m3	EPA TO-15
1,1-Dichloroethene (1,1-Dichloroethylene)	0.25	ug/L	EPA 8260C	0.078	ug/m3	EPA TO-15
1,1-Dichloropropene	0.13	ug/L	EPA 8260C	Not Analyzed for Soil Gas		
1,2,3-Trichlorobenzene	0.095	ug/L	EPA 8260C	Not Analyzed for Soil Gas		
1,2,3-Trichloropropane	0.4	ug/L	EPA 8260C	Not Analyzed for Soil Gas		
1,2,4-Trichlorobenzene	0.16	ug/L	EPA 8260C	0.15	ug/m3	EPA TO-15
1,2,4-Trimethylbenzene	0.095	ug/L	EPA 8260C	0.11	ug/m3	EPA TO-15
1,2-Dibromo-3-Chloropropane (DBCP)	0.31	ug/L	EPA 8260C	Not Analyzed for Soil Gas		
1,2-Dibromoethane (EDB)	0.14	ug/L	EPA 8260C	0.17	ug/m3	EPA TO-15
1,2-Dichlorobenzene	0.11	ug/L	EPA 8260C	0.13	ug/m3	EPA TO-15
1,2-Dichloroethane	0.13	ug/L	EPA 8260C	0.11	ug/m3	EPA TO-15
1,2-Dichloropropane	0.13	ug/L	EPA 8260C	0.098	ug/m3	EPA TO-15
1,2-Dichlorotetrafluoroethane (Freon 114)	Not Analyzed for Groundwater			0.14	ug/m3	EPA TO-15
1,3,5-Trimethylbenzene	0.060	ug/L	EPA 8260C	0.10	ug/m3	EPA TO-15
1,3-Butadiene	Not Analyzed for Groundwater			0.094	ug/m3	EPA TO-15
1,3-Dichlorobenzene	0.097	ug/L	EPA 8260C	0.13	ug/m3	EPA TO-15
1,3-Dichloropropane	0.13	ug/L	EPA 8260C	Not Analyzed for Soil Gas		
1,4-Dichlorobenzene	0.12	ug/L	EPA 8260C	0.13	ug/m3	EPA TO-15
1,4-Dioxane	Not Analyzed for Groundwater			0.076	ug/m3	EPA TO-15
2,2-Dichloropropane	0.26	ug/L	EPA 8260C	Not Analyzed for Soil Gas		
3-Chloropropene	Not Analyzed for Groundwater			0.14	ug/m3	EPA TO-15
4-Ethyltoluene	Not Analyzed for Groundwater			0.21	ug/m3	EPA TO-15
Acetone	4.0	ug/L	EPA 8260C	0.079	ug/m3	EPA TO-15
Acrylonitrile	Not Analyzed for Groundwater			0.051	ug/m3	EPA TO-15
Benzene	0.10	ug/L	EPA 8260C	0.067	ug/m3	EPA TO-15
Benzyl chloride	Not Analyzed for Groundwater			0.11	ug/m3	EPA TO-15



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TABLE 2 - SESD VOC Target Analytes (2 of 3)

Analyte	Groundwater			Soil Gas		
	MDL	Units	Specific Method	MDL	Units	Specific Method
Bromobenzene	0.096	ug/L	EPA 8260C	Not Analyzed for Soil Gas		
Bromochloromethane	0.13	ug/L	EPA 8260C	Not Analyzed for Soil Gas		
Bromodichloromethane	0.11	ug/L	EPA 8260C	0.14	ug/m3	EPA TO-15
Bromoform	0.24	ug/L	EPA 8260C	0.22	ug/m3	EPA TO-15
Bromomethane	1.6	ug/L	EPA 8260C	0.082	ug/m3	EPA TO-15
Carbon disulfide	0.27	ug/L	EPA 8260C	0.065	ug/m3	EPA TO-15
Carbon Tetrachloride	0.19	ug/L	EPA 8260C	0.13	ug/m3	EPA TO-15
Chlorobenzene	0.076	ug/L	EPA 8260C	0.098	ug/m3	EPA TO-15
Chloroethane	0.32	ug/L	EPA 8260C	0.087	ug/m3	EPA TO-15
Chloroform	0.20	ug/L	EPA 8260C	0.10	ug/m3	EPA TO-15
Chloromethane	0.35	ug/L	EPA 8260C	0.048	ug/m3	EPA TO-15
cis-1,2-Dichloroethene	0.15	ug/L	EPA 8260C	0.083	ug/m3	EPA TO-15
cis-1,3-Dichloropropene	0.067	ug/L	EPA 8260C	0.094	ug/m3	EPA TO-15
Cyclohexane	0.16	ug/L	EPA 8260C	0.072	ug/m3	EPA TO-15
Dibromochloromethane	0.13	ug/L	EPA 8260C	0.18	ug/m3	EPA TO-15
Dibromomethane	0.24	ug/L	EPA 8260C	Not Analyzed for Soil Gas		
Dichlorodifluoromethane (Freon 12)	0.16	ug/L	EPA 8260C	0.11	ug/m3	EPA TO-15
Ethyl Acetate	Not Analyzed for Groundwater			0.098	ug/m3	EPA TO-15
Ethyl Benzene	0.065	ug/L	EPA 8260C	0.092	ug/m3	EPA TO-15
Heptane	Not Analyzed for Groundwater			0.087	ug/m3	EPA TO-15
Hexachlorobutadiene	0.24	ug/L	EPA 8260C	0.21	ug/m3	EPA TO-15
Hexane	Not Analyzed for Groundwater			0.073	ug/m3	EPA TO-15
Isooctane	Not Analyzed for Groundwater			0.098	ug/m3	EPA TO-15
Isopropanol	Not Analyzed for Groundwater			0.054	ug/m3	EPA TO-15
Isopropylbenzene	0.060	ug/L	EPA 8260C	Not Analyzed for Soil Gas		
Methyl Acetate	0.67	ug/L	EPA 8260C	Not Analyzed for Soil Gas		
Methyl Butyl Ketone	0.32	ug/L	EPA 8260C	0.087	ug/m3	EPA TO-15
Methyl Ethyl Ketone	0.80	ug/L	EPA 8260C	0.063	ug/m3	EPA TO-15
Methyl Isobutyl Ketone	0.22	ug/L	EPA 8260C	0.087	ug/m3	EPA TO-15
Methyl T-Butyl Ether (MTBE)	0.099	ug/L	EPA 8260C	0.078	ug/m3	EPA TO-15
Methylcyclohexane	0.13	ug/L	EPA 8260C	Not Analyzed for Soil Gas		



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TABLE 2 - SESD VOC Target Analytes (3 of 3)

Analyte	Groundwater			Soil Gas		
	MDL	Units	Specific Method	MDL	Units	Specific Method
Methylene Chloride	0.13	ug/L	EPA 8260C	0.077	ug/m3	EPA TO-15
Naphthalene	0.13	ug/L	EPA 8260C	Not Analyzed for Soil Gas		
n-Butylbenzene	0.078	ug/L	EPA 8260C	Not Analyzed for Soil Gas		
n-Propylbenzene	0.071	ug/L	EPA 8260C	Not Analyzed for Soil Gas		
o-Chlorotoluene	0.076	ug/L	EPA 8260C	Not Analyzed for Soil Gas		
o-Xylene	0.062	ug/L	EPA 8260C	0.093	ug/m3	EPA TO-15
p-Chlorotoluene	0.083	ug/L	EPA 8260C	Not Analyzed for Soil Gas		
p-Isopropyltoluene	0.088	ug/L	EPA 8260C	Not Analyzed for Soil Gas		
Propene	Not Analyzed for Groundwater			0.03	ug/m3	EPA TO-15
sec-Butylbenzene	0.071	ug/L	EPA 8260C	Not Analyzed for Soil Gas		
Styrene	0.11	ug/L	EPA 8260C	0.089	ug/m3	EPA TO-15
tert-Butylbenzene	0.074	ug/L	EPA 8260C	Not Analyzed for Soil Gas		
Tetrachloroethene (Tetrachloroethylene)	0.15	ug/L	EPA 8260C	0.14	ug/m3	EPA TO-15
Tetrahydrofuran	Not Analyzed for Groundwater			0.061	ug/m3	EPA TO-15
Toluene	0.094	ug/L	EPA 8260C	0.080	ug/m3	EPA TO-15
trans-1,2-Dichloroethene	0.17	ug/L	EPA 8260C	0.087	ug/m3	EPA TO-15
trans-1,3-Dichloropropene	0.15	ug/L	EPA 8260C	0.10	ug/m3	EPA TO-15
Trichloroethene (Trichloroethylene)	0.18	ug/L	EPA 8260C	0.11	ug/m3	EPA TO-15
Trichlorofluoromethane (Freon 11)	0.20	ug/L	EPA 8260C	0.12	ug/m3	EPA TO-15
Vinyl acetate	Not Analyzed for Groundwater			0.083	ug/m3	EPA TO-15
Vinyl bromide	Not Analyzed for Groundwater			0.094	ug/m3	EPA TO-15
Vinyl chloride	0.36	ug/L	EPA 8260C	0.053	ug/m3	EPA TO-15

Pressley, Miriam

From: Bastek, Brian
Sent: Wednesday, September 30, 2015 3:29 PM
To: Ellis, John
Subject: RE: Grenada Manufacturing - Modification to the IMWP Groundwater Sampling Portion

Yes, just left you a vm. Call my cell any time before 5. Thanks.

Brian Bastek
Environmental Engineer
U.S. EPA, Region 4
RCRA Corrective Action and Permitting Section
Resource Conservation and Restoration Division
61 Forsyth Street, SW
Atlanta, GA 30303
404-562-8511
bastek.brian@epa.gov

From: Ellis, John [<mailto:John.Ellis@arcadis.com>]
Sent: Wednesday, September 30, 2015 2:46 PM
To: Bastek, Brian
Subject: RE: Grenada Manufacturing - Modification to the IMWP Groundwater Sampling Portion

Hey Brian – Do you have a minute to chat this afternoon? Just left you a voice mail.
Thanks,
John

From: Bastek, Brian [<mailto:Bastek.Brian@epa.gov>]
Sent: Tuesday, September 29, 2015 8:15 AM
To: Ellis, John <John.Ellis@arcadis.com>
Subject: RE: Grenada Manufacturing - Modification to the IMWP Groundwater Sampling Portion

Call you in a few minutes. Running a little behind this morning...

Brian Bastek
Environmental Engineer
U.S. EPA, Region 4
RCRA Corrective Action and Permitting Section
Resource Conservation and Restoration Division
61 Forsyth Street, SW
Atlanta, GA 30303
404-562-8511
bastek.brian@epa.gov

From: Ellis, John [<mailto:John.Ellis@arcadis.com>]
Sent: Monday, September 28, 2015 5:36 PM

To: Bastek, Brian

Subject: RE: Grenada Manufacturing - Modification to the IMWP Groundwater Sampling Portion

I am open all morning. Does 9 EST work for you?

From: Bastek, Brian [<mailto:Bastek.Brian@epa.gov>]

Sent: Monday, September 28, 2015 3:41 PM

To: Ellis, John <John.Ellis@arcadis.com>

Subject: FW: Grenada Manufacturing - Modification to the IMWP Groundwater Sampling Portion

Hi John.

Here are the answers to your requests below. Let's discuss tomorrow morning if you are available.

Brian Bastek
Environmental Engineer
U.S. EPA, Region 4
RCRA Corrective Action and Permitting Section
Resource Conservation and Restoration Division
61 Forsyth Street, SW
Atlanta, GA 30303
404-562-8511
bastek.brian@epa.gov

From: Bentkowski, Ben

Sent: Monday, September 28, 2015 3:38 PM

To: Bastek, Brian

Subject: FW: Grenada Manufacturing - Modification to the IMWP Groundwater Sampling Portion

Brian,
Here are the responses to your questions from Arcadis as supplied by Nardina Turner, our chemist. As we discussed on the phone, we are generally not in favor of granting these variations from the SAP. Also, you said that Arcadis is aware of the risks for resampling should there be problems. On that basis, in my opinion, Arcadis is proceeding at risk.

Thanks,
Ben

Ben Bentkowski, P.G.
USEPA R4 Superfund Scientific Support Section
61 Forsyth St
ATL, GA 30303
(404) 562-8507 office
New Work Cell Phone
(470) 295-5620

(b)(6) personal cell

From: Turner, Nardina

Sent: Monday, September 28, 2015 2:16 PM

To: Bentkowski, Ben

Subject: RE: Grenada Manufacturing - Modification to the IMWP Groundwater Sampling Portion

Hexavalent Chromium: Consistent with our own SOP, Region 4 would accept 218.6 very readily. Since 218.7 is specifically for drinking water collected at the tap, it does not cover the filtration aspect. We do believe filtration in the field within 15 minutes of collection is important, as particulate can really throw off the measurement. Similarly, SM 3500 allows for unfiltered or filtered, and 218.6 as promulgated is strictly filtered/dissolved, and we want to stick to that. Most importantly, the change in analytical method only extends the holding time by virtue of including preservation instructions. The analytical approach is essentially still the same as SW-846 7196. It's just that 7196 has not been updated to include the preservation discussion. The preservative involves multiple chemicals and cannot be easily made in the field. Generally, the laboratory would send pre-preserved bottles. If the samples are collected without the preservative, then the 24 hour holding time applies, regardless of method.

SVOA: Region 4 has not previously used this option and would have some reservations based on just the information below and the limited time to research it. In looking at the method, it appears to be validated only for particular compound groups and not for all SVOA compounds, so the suitability of the method may depend on the site targets. The method does not discuss a sample volume of 250 mL and seems to primarily reference VOA vials. The origin of that 250 mL volume reference is unclear. If the site targets allow for the method to be used, the Region would need to see the performance data for the laboratory to demonstrate their accuracy, precision, and reporting level for a 250 mL volume sample prior to deciding about this method. Additionally, it should be noted that the 2-L requirement is for 1-L plus a 1-L backup. For extractables of any type, it is not unusual to need the backup. So, if a reduced volume is to be used, a backup volume should still be considered.

Tubing: A similar issue came up with one of Deb Cox's sites, and we called upon Brian Striggow at SEDS to advise us. It may be worth referring to whatever write-up Deb has for this, as it was researched pretty thoroughly. As I recall, some compromise was made based on the fact that very high levels were expected for that site. Most consent decrees required the Region 4 SOPs at one time (not sure what model language appeared in this one), so although FDEP is allowing Polyethylene except for VOAs, we would want to characterize any deviation in terms of the EPA SOP <http://www.epa.gov/region4/sesd/fbgstp/Groundwater-Sampling.pdf>. However, I am not sure it actually requires 1000's of feet of tubing as a number of options are discussed. The SEDS field folks need to look at this and may need more information on the sampling technique than what is below. Jon Vail is the author of the groundwater SOP, so if he is available, then Brian should start with him.

From: Bentkowski, Ben

Sent: Monday, September 28, 2015 12:00 PM

To: Turner, Nardina

Subject: FW: Grenada Manufacturing - Modification to the IMWP Groundwater Sampling Portion

Importance: High

These should work better. I was trying it before from my phone.

Thanks,

Ben

Ben Bentkowski, P.G.

USEPA R4 Superfund Scientific Support Section

61 Forsyth St

ATL, GA 30303

(404) 562-8507 office

New Work Cell Phone

(470) 295-5620

(b)(6) personal cell

From: Bastek, Brian
Sent: Monday, September 28, 2015 9:27 AM
To: Anderson, Meredith; Bentkowski, Ben
Subject: FW: Grenada Manufacturing - Modification to the IMWP Groundwater Sampling Portion
Importance: High

Thoughts on these requests?

I don't have any real issues with what they are proposing; as long as these deviations are notated in their final report. Who from SESD should weigh in on this?

Thanks.

Brian Bastek
Environmental Engineer
U.S. EPA, Region 4
RCRA Corrective Action and Permitting Section
Resource Conservation and Restoration Division
61 Forsyth Street, SW
Atlanta, GA 30303
404-562-8511
bastek.brian@epa.gov

From: Ellis, John [<mailto:John.Ellis@arcadis.com>]
Sent: Friday, September 25, 2015 10:22 AM
To: Bastek, Brian
Subject: Grenada Manufacturing - Modification to the IMWP Groundwater Sampling Portion
Importance: High

Brian,

ARCADIS is requesting the US Environmental Protection Agency (USEPA) Region 4 approve the following modifications to the soil and groundwater sampling portion of the Interim Measures Work Plan (IMWP). Each of the requested changes is to an approved sampling method or procedure that is currently utilized within both USEPA and State Regulatory programs. The three requested modifications concern the hexavalent chromium method, a low volume sample volume for SVOC analysis, and use of high density polyethylene tubing. The approval of the requested modifications will enable us to implement the soil and groundwater sampling program in a more efficient and cost-effective manner.

1. Hexavalent Chromium Method:

We are requesting to use USEPA Method 218.6 or 218.7, or Standard Method 3500-Cr B to analyze for hexavalent chromium in groundwater. All methods are approved by the US EPA. A copy of both USEPA methods are attached and a link to the US EPA website discussing these methods is also attached and included below. These methods allow for longer hold times before laboratory analysis is required on the collected samples. Currently, the work plan calls for Method 7196 which requires the sample to be submitted and analyzed by the laboratory within 24 hours. This short hold time will significantly inhibit our ability to efficiently sample groundwater.

<http://water.epa.gov/drink/info/chromium/guidance.cfm#thirteen>

2. Low Volume SVOC Sampling

We are requesting to use the micro-extraction (low-volume) USEPA Method 3511 via Method 8270 and 8270SIM to analyze for SVOCs. This method allows for a reduction of the sample volume required, from 2 one-liter amber bottles to one 250-mL amber bottle. Again, this method is permitted and commonly utilized throughout the various USEPA regions and State Regulatory agencies.

3. Use of polyethylene tubing for purging and sampling

We are requesting to use polyethylene tubing, rather than Teflon-lined tubing, to collect the groundwater samples. The Vertical Aquifer Profile (VAP) sampling requires 1,000's of feet of tubing to collect the groundwater samples from the water table to a 50 ft depth in each of the ten EPA requested location. The cost savings from using the Teflon-lined tubing is dramatic, and there are many studies which demonstrate no significant difference in concentrations between the two types of tubing (see the attached Florida DEQ article).

ARCADIS appreciates your review of these proposed modifications and looks forward to receiving your response shortly.

Thank you

Steven C. Sharp, LPG (IN) | Senior Geologist CPM-2 | steve_sharp@arcadis-us.com



ARCADIS U.S., Inc. | 132 East Washington Street, Suite 600 | Indianapolis, IN 46204

T: 317.236.2829 (b)(6)

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Pressley, Miriam

From: Bastek, Brian
Sent: Wednesday, September 30, 2015 3:29 PM
To: Ellis, John
Subject: RE: Grenada Manufacturing - Modification to the IMWP Groundwater Sampling Portion

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Brian Bastek
Environmental Engineer
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Resource Conservation and Restoration Division
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John

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Sent: Tuesday, September 29, 2015 8:15 AM
To: Ellis, John <John.Ellis@arcadis.com>
Subject: RE: Grenada Manufacturing - Modification to the IMWP Groundwater Sampling Portion

Call you in a few minutes. Running a little behind this morning...

Brian Bastek
Environmental Engineer
U.S. EPA, Region 4
RCRA Corrective Action and Permitting Section
Resource Conservation and Restoration Division
61 Forsyth Street, SW
Atlanta, GA 30303
404-562-8511
bastek.brian@epa.gov

From: Ellis, John [<mailto:John.Ellis@arcadis.com>]
Sent: Monday, September 28, 2015 5:36 PM

To: Bastek, Brian

Subject: RE: Grenada Manufacturing - Modification to the IMWP Groundwater Sampling Portion

I am open all morning. Does 9 EST work for you?

From: Bastek, Brian [<mailto:Bastek.Brian@epa.gov>]

Sent: Monday, September 28, 2015 3:41 PM

To: Ellis, John <John.Ellis@arcadis.com>

Subject: FW: Grenada Manufacturing - Modification to the IMWP Groundwater Sampling Portion

Hi John.

Here are the answers to your requests below. Let's discuss tomorrow morning if you are available.

Brian Bastek
Environmental Engineer
U.S. EPA, Region 4
RCRA Corrective Action and Permitting Section
Resource Conservation and Restoration Division
61 Forsyth Street, SW
Atlanta, GA 30303
404-562-8511
bastek.brian@epa.gov

From: Bentkowski, Ben

Sent: Monday, September 28, 2015 3:38 PM

To: Bastek, Brian

Subject: FW: Grenada Manufacturing - Modification to the IMWP Groundwater Sampling Portion

Brian,
Here are the responses to your questions from Arcadis as supplied by Nardina Turner, our chemist. As we discussed on the phone, we are generally not in favor of granting these variations from the SAP. Also, you said that Arcadis is aware of the risks for resampling should there be problems. On that basis, in my opinion, Arcadis is proceeding at risk.

Thanks,
Ben

Ben Bentkowski, P.G.
USEPA R4 Superfund Scientific Support Section
61 Forsyth St
ATL, GA 30303
(404) 562-8507 office
New Work Cell Phone
(470) 295-5620

(b)(6) / personal cell

From: Turner, Nardina

Sent: Monday, September 28, 2015 2:16 PM

To: Bentkowski, Ben

Subject: RE: Grenada Manufacturing - Modification to the IMWP Groundwater Sampling Portion

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From: Bentkowski, Ben

Sent: Monday, September 28, 2015 12:00 PM

To: Turner, Nardina

Subject: FW: Grenada Manufacturing - Modification to the IMWP Groundwater Sampling Portion

Importance: High

These should work better. I was trying it before from my phone.

Thanks,

Ben

Ben Bentkowski, P.G.

USEPA R4 Superfund Scientific Support Section

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ATL,GA 30303

(404) 562-8507 office

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From: Bastek, Brian
Sent: Monday, September 28, 2015 9:27 AM
To: Anderson, Meredith; Bentkowski, Ben
Subject: FW: Grenada Manufacturing - Modification to the IMWP Groundwater Sampling Portion
Importance: High

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From: Ellis, John [<mailto:John.Ellis@arcadis.com>]
Sent: Friday, September 25, 2015 10:22 AM
To: Bastek, Brian
Subject: Grenada Manufacturing - Modification to the IMWP Groundwater Sampling Portion
Importance: High

Brian,

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<http://water.epa.gov/drink/info/chromium/guidance.cfm#thirteen>

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ARCADIS appreciates your review of these proposed modifications and looks forward to receiving your response shortly.

Thank you

Steven C. Sharp, LPG (IN) | Senior Geologist CPM-2 | steve.sharp@arcadis-us.com



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Pressley, Miriam

From: Bastek, Brian
Sent: Wednesday, September 30, 2015 12:17 PM
To: O'Connor, David A.
Cc: Anderson, Meredith
Subject: RE: Grenada Manufacturing, LLC - Submission of 2013 and 2014 Annual Reports

OK, we'll call you at 2:30 tomorrow (if we aren't shutdown).

Brian Bastek
Environmental Engineer
U.S. EPA, Region 4
RCRA Corrective Action and Permitting Section
Resource Conservation and Restoration Division
61 Forsyth Street, SW
Atlanta, GA 30303
404-562-8511
bastek.brian@epa.gov

From: O'Connor, David A. [mailto:David.OConnor@Meritor.com]
Sent: Wednesday, September 30, 2015 12:01 PM
To: Bastek, Brian
Subject: RE: Grenada Manufacturing, LLC - Submission of 2013 and 2014 Annual Reports

Brian:

I am available any time after 11:00am EST tomorrow.

MERITOR

David A. O'Connor
Corporate Environmental Manager
Treasury Department
248.435.2706 tel
248.435.8354 fax
(b)(6)
david.oconnor@meritor.com

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Troy, Michigan 48084
USA
www.meritor.com

From: Bastek, Brian [mailto:Bastek.Brian@epa.gov]
Sent: Wednesday, September 30, 2015 10:32 AM
To: O'Connor, David A.
Subject: RE: Grenada Manufacturing, LLC - Submission of 2013 and 2014 Annual Reports

Dave,

Do you have time for a quick call tomorrow with Meredith and I? If so, what is a good time? Thanks.

Brian Bastek

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From: O'Connor, David A. [<mailto:David.OConnor@Meritor.com>]
Sent: Friday, September 18, 2015 3:01 PM
To: Bastek, Brian
Cc: dwilliams@iceindustries.com; Jim Peeples
Subject: RE: Grenada Manufacturing, LLC - Submission of 2013 and 2014 Annual Reports

Brian:

I have talked to Jim Peeples and we believe the CY2013 and CY2014 annual reports will be issued early October. At this time I do not have any questions concerning the comments to the CY2012 report. Call me should you have any questions. Thanks.

MERITOR

David A. O'Connor
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From: Bastek, Brian [<mailto:Bastek.Brian@epa.gov>]
Sent: Friday, September 18, 2015 1:50 PM
To: O'Connor, David A.
Cc: dwilliams@iceindustries.com
Subject: Grenada Manufacturing, LLC - Submission of 2013 and 2014 Annual Reports

Hi Dave. Hope things are well with you.

I wanted to check on the status of submitting these two reports per the attached letter. I haven't received any communications from you so I am assuming there are no questions regarding the comments. Please let me know what your timeline is regarding these submittals.

Thank you.

Brian Bastek
Environmental Engineer
U.S. EPA, Region 4
RCRA Corrective Action and Permitting Section
Resource Conservation and Restoration Division

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Pressley, Miriam

From: Bastek, Brian
Sent: Tuesday, September 29, 2015 9:15 AM
To: Ellis, John
Subject: RE: Grenada Manufacturing - Modification to the IMWP Groundwater Sampling Portion

Call you in a few minutes. Running a little behind this morning...

Brian Bastek
Environmental Engineer
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Steven C. Sharp, LPG (IN) | Senior Geologist CPM-2 | steve.sharp@arcadis-us.com



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Pressley, Miriam

From: Bastek, Brian
Sent: Monday, September 28, 2015 4:41 PM
To: Ellis, John
Subject: FW: Grenada Manufacturing - Modification to the IMWP Groundwater Sampling Portion

Hi John.

Here are the answers to your requests below. Let's discuss tomorrow morning if you are available.

Brian Bastek
Environmental Engineer
U.S. EPA, Region 4
RCRA Corrective Action and Permitting Section
Resource Conservation and Restoration Division
61 Forsyth Street, SW
Atlanta, GA 30303
404-562-8511
bastek.brian@epa.gov

From: Bentkowski, Ben
Sent: Monday, September 28, 2015 3:38 PM
To: Bastek, Brian
Subject: FW: Grenada Manufacturing - Modification to the IMWP Groundwater Sampling Portion

Brian,
Here are the responses to your questions from Arcadis as supplied by Nardina Turner, our chemist. As we discussed on the phone, we are generally not in favor of granting these variations from the SAP. Also, you said that Arcadis is aware of the risks for resampling should there be problems. On that basis, in my opinion, Arcadis is proceeding at risk.

Thanks,
Ben

Ben Bentkowski, P.G.
USEPA R4 Superfund Scientific Support Section
61 Forsyth St
ATL,GA 30303
(404) 562-8507 office
New Work Cell Phone
(470) 295-5620
(b)(6) personal cell

From: Turner, Nardina
Sent: Monday, September 28, 2015 2:16 PM
To: Bentkowski, Ben
Subject: RE: Grenada Manufacturing - Modification to the IMWP Groundwater Sampling Portion

Hexavalent Chromium: Consistent with our own SOP, Region 4 would accept 218.6 very readily. Since 218.7 is specifically for drinking water collected at the tap, it does not cover the filtration aspect. We do believe filtration in the field within 15 minutes of collection is important, as particulate can really throw off the measurement. Similarly, SM 3500 allows for unfiltered or filtered, and 218.6 as promulgated is strictly filtered/dissolved, and we want to stick to that. Most importantly, the change in analytical method only extends the holding time by virtue of including preservation instructions. The analytical approach is essentially still the same as SW-846 7196. It's just that 7196 has not been updated to include the preservation discussion. The preservative involves multiple chemicals and cannot be easily made in the field. Generally, the laboratory would send pre-preserved bottles. If the samples are collected without the preservative, then the 24 hour holding time applies, regardless of method.

SVOA: Region 4 has not previously used this option and would have some reservations based on just the information below and the limited time to research it. In looking at the method, it appears to be validated only for particular compound groups and not for all SVOA compounds, so the suitability of the method may depend on the site targets. The method does not discuss a sample volume of 250 mL and seems to primarily reference VOA vials. The origin of that 250 mL volume reference is unclear. If the site targets allow for the method to be used, the Region would need to see the performance data for the laboratory to demonstrate their accuracy, precision, and reporting level for a 250 mL volume sample prior to deciding about this method. Additionally, it should be noted that the 2-L requirement is for 1-L plus a 1-L backup. For extractables of any type, it is not unusual to need the backup. So, if a reduced volume is to be used, a backup volume should still be considered.

Tubing: A similar issue came up with one of Deb Cox's sites, and we called upon Brian Striggow at SESD to advise us. It may be worth referring to whatever write-up Deb has for this, as it was researched pretty thoroughly. As I recall, some compromise was made based on the fact that very high levels were expected for that site. Most consent decrees required the Region 4 SOPs at one time (not sure what model language appeared in this one), so although FDEP is allowing Polyethylene except for VOAs, we would want to characterize any deviation in terms of the EPA SOP <http://www.epa.gov/region4/sesd/fbqstp/Groundwater-Sampling.pdf>. However, I am not sure it actually requires 1000's of feet of tubing as a number of options are discussed. The SESD field folks need to look at this and may need more information on the sampling technique than what is below. Jon Vail is the author of the groundwater SOP, so if he is available, then Brian should start with him.

From: Bentkowski, Ben

Sent: Monday, September 28, 2015 12:00 PM

To: Turner, Nardina

Subject: FW: Grenada Manufacturing - Modification to the IMWP Groundwater Sampling Portion

Importance: High

These should work better. I was trying it before from my phone.

Thanks,

Ben

Ben Bentkowski, P.G.

USEPA R4 Superfund Scientific Support Section

61 Forsyth St

ATL,GA 30303

(404) 562-8507 office

New Work Cell Phone

(470) 295-5620

(b)(6)) personal cell

From: Bastek, Brian
Sent: Monday, September 28, 2015 9:27 AM
To: Anderson, Meredith; Bentkowski, Ben
Subject: FW: Grenada Manufacturing - Modification to the IMWP Groundwater Sampling Portion
Importance: High

Thoughts on these requests?

I don't have any real issues with what they are proposing; as long as these deviations are notated in their final report. Who from SEDS should weigh in on this?

Thanks.

Brian Bastek
Environmental Engineer
U.S. EPA, Region 4
RCRA Corrective Action and Permitting Section
Resource Conservation and Restoration Division
61 Forsyth Street, SW
Atlanta, GA 30303
404-562-8511
bastek.brian@epa.gov

From: Ellis, John [<mailto:John.Ellis@arcadis.com>]
Sent: Friday, September 25, 2015 10:22 AM
To: Bastek, Brian
Subject: Grenada Manufacturing - Modification to the IMWP Groundwater Sampling Portion
Importance: High

Brian,

ARCADIS is requesting the US Environmental Protection Agency (USEPA) Region 4 approve the following modifications to the soil and groundwater sampling portion of the Interim Measures Work Plan (IMWP). Each of the requested changes is to an approved sampling method or procedure that is currently utilized within both USEPA and State Regulatory programs. The three requested modifications concern the hexavalent chromium method, a low volume sample volume for SVOC analysis, and use of high density polyethylene tubing. The approval of the requested modifications will enable us to implement the soil and groundwater sampling program in a more efficient and cost-effective manner.

1. Hexavalent Chromium Method:

We are requesting to use USEPA Method 218.6 or 218.7, or Standard Method 3500-Cr B to analyze for hexavalent chromium in groundwater. All methods are approved by the US EPA. A copy of both USEPA methods are attached and a link to the US EPA website discussing these methods is also attached and included below. These methods allow for longer hold times before laboratory analysis is required on the collected samples. Currently, the work plan calls for Method 7196 which requires the sample to be submitted and analyzed by the laboratory within 24 hours. This short hold time will significantly inhibit our ability to efficiently sample groundwater.

<http://water.epa.gov/drink/info/chromium/guidance.cfm#thirteen>

2. Low Volume SVOC Sampling

We are requesting to use the micro-extraction (low-volume) USEPA Method 3511 via Method 8270 and 8270SIM to analyze for SVOCs. This method allows for a reduction of the sample volume required, from 2 one-

liter amber bottles to one 250-mL amber bottle. Again, this method is permitted and commonly utilized throughout the various USEPA regions and State Regulatory agencies.

3. Use of polyethylene tubing for purging and sampling

We are requesting to use polyethylene tubing, rather than Teflon-lined tubing, to collect the groundwater samples. The Vertical Aquifer Profile (VAP) sampling requires 1,000's of feet of tubing to collect the groundwater samples from the water table to a 50 ft depth in each of the ten EPA requested location. The cost savings from using the Teflon-lined tubing is dramatic, and there are many studies which demonstrate no significant difference in concentrations between the two types of tubing (see the attached Florida DEQ article).

ARCADIS appreciates your review of these proposed modifications and looks forward to receiving your response shortly.

Thank you

Steven C. Sharp, LPG (IN) | Senior Geologist CPM-2 | steve.sharp@arcadis-us.com



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T: 317.236.2829 | M: (b)(6)

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Pressley, Miriam

From: Bastek, Brian
Sent: Monday, September 28, 2015 9:27 AM
To: Anderson, Meredith; Bentkowski, Ben
Subject: FW: Grenada Manufacturing - Modification to the IMWP Groundwater Sampling Portion
Attachments: Wastewater Standard Methods 2011 Revisions 6-20-2012 final.pdf; EPA_Method_218-7.pdf; 2007_07_10_methods_method_218_6.pdf; EPA Method 3511.pdf; FS 2200 Groundwater Sampling SOP.PDF

Importance: High

Thoughts on these requests?

I don't have any real issues with what they are proposing; as long as these deviations are notated in their final report. Who from SESD should weigh in on this?

Thanks.

Brian Bastek
Environmental Engineer
U.S. EPA, Region 4
RCRA Corrective Action and Permitting Section
Resource Conservation and Restoration Division
61 Forsyth Street, SW
Atlanta, GA 30303
404-562-8511
bastek.brian@epa.gov

From: Ellis, John [mailto:John.Ellis@arcadis.com]
Sent: Friday, September 25, 2015 10:22 AM
To: Bastek, Brian
Subject: Grenada Manufacturing - Modification to the IMWP Groundwater Sampling Portion
Importance: High

Brian,

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ARCADIS appreciates your review of these proposed modifications and looks forward to receiving your response shortly.

Thank you

Steven C. Sharp, LPG (IN) | Senior Geologist CPM-2 | steve.sharp@arcadis-us.com



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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

Rodger Baird
Joint Editorial Board
Standard Methods
3645 Country Meadow Lane
Escondido, CA 92025
mrbaire@earthlink.net

ATP Case Number ADMINISTRATOR
N12-0006

Dear Mr. Baird,

June 20, 2012

The Engineering and Analytical Support Branch (EASB) has reviewed several methods published in the 22nd Edition of *Standard Methods for the Examination of Water and Wastewater* (Standard Methods) and the on-line version of Standard Methods. These methods include editorial changes to the previously approved versions of the methods that were included in the most recent Method Update Rule (MUR) published in the *Federal Register* on May 18, 2012 (77 FR 29758).

Based on this review, EASB has determined that these methods are acceptable versions of the approved methods listed at Title 40 of the Code of Federal Regulations (40 CFR) part 136.3, Tables IB and IC, and may be used for compliance monitoring performed under the Clean Water Act. Table 1 lists the approved version of each Standard Method that was included in the MUR and the corresponding editorially revised 2011 version published in the 22nd Edition of Standard Methods and the on-line version of Standard Methods.

Table 1

Approved Standard Method in Most Recent MUR	Standard Methods 22 nd Edition Editorial Revisions
2120 B-2001	2120 B-2011
2130 B-2001	2130 B-2011
2310 B-1997	2310 B-2011
2320 B-1997	2320 B-2011
2340 B-1997	2340 B-2011
2340 C-1997	2340 C-2011
2510 B-1997	2510 B-2011
2540 B-1997	2540 B-2011
2540 C-1997	2540 C-2011
2540 D-1997	2540 D-2011
2540 E-1997	2540 E-2011
2540 F-1997	2540 F-2011
3111 B-1999	3111 B-2011

Table 1 (continued)

3111 C-1999	3111 C-2011
3111 D-1999	3111 D-2011
3111 E-1999	3111 E-2011
3112 B-2009	3112 B-2011
3113 B-2004	3113 B-2011
3114 B-2009	3114 B-2011
3114 C-2009	3114 C-2011
3120 B-1999	3120 B-2011
3125 B-2009	3125 B-2011
3500-Al B-2001	3500-Al B-2011
3500-As B-1997	3500-As B-2011
3500-Ca B-1997	3500-Ca B-2011
3500-Cr B-2009	3500-Cr B-2011
3500-Cr C-2009	3500-Cr C-2011
3500-Cu B-1999	3500-Cu B-2011
3500-Cu C-1999	3500-Cu C-2011
3500-Fe B-1997	3500-Fe B-2011
3500-K B-1997	3500-K B-2011
3500-K C-1997	3500-K C-2011
3500-Mn B-1999	3500-Mn B-2011
3500 Na B-1997	3500-Na B-2011
3500-Pb B-1997	3500-Pb B-2011
3500-V B-1997	3500-V B-2011
3500-Zn B-1997	3500-Zn B-2011
4110 B-2000	4110 B-2011
4110 C-2000	4110 C-2011
4110 D-2000	4110 D-2011
4140 B-1997	4140 B-2011
4500-B B-2000	4500-B B-2011
4500-Cl ⁻ B-1997	4500-Cl ⁻ B-2011
4500-Cl ⁻ C-1997	4500-Cl ⁻ C-2011
4500-Cl ⁻ D-1997	4500-Cl ⁻ D-2011
4500-Cl ⁻ E-1997	4500-Cl ⁻ E-2011
4500-Cl B-2000	4500-Cl B-2011
4500-Cl C-2000	4500-Cl C-2011
4500-Cl D-2000	4500-Cl D-2011
4500-Cl E-2000	4500-Cl E-2011
4500-Cl F-2000	4500-Cl F-2011
4500-Cl G-2000	4500-Cl G-2011
4500-CN ⁻ B-1999	4500-CN ⁻ B-2011
4500-CN ⁻ C-1999	4500-CN ⁻ C-2011

Table 1 (Continued)

4500-CN ⁻ D-1999	4500-CN ⁻ D-2011
4500-CN ⁻ E-1999	4500-CN ⁻ E-2011
4500-CN ⁻ F-1999	4500-CN ⁻ F-2011
4500-CN ⁻ G-1999	4500-CN ⁻ G-2011
4500-F ⁻ B-1997	4500-F ⁻ B-2011
4500-F ⁻ C-1997	4500-F ⁻ C-2011
4500-F ⁻ D-1997	4500-F ⁻ D-2011
4500-F ⁻ E-1997	4500-F ⁻ E-2011
4500-H ⁺ -2000	4500-H ⁺ -2011
4500-N _{org} B-1997	4500-N _{org} B-2011
4500-N _{org} C-1997	4500-N _{org} C-2011
4500-N _{org} D-1997	4500-N _{org} D-2011
4500-NH ₃ B-1997	4500-NH ₃ B-2011
4500-NH ₃ C-1997	4500-NH ₃ C-2011
4500-NH ₃ D-1997	4500-NH ₃ D-2011
4500-NH ₃ E-1997	4500-NH ₃ E-2011
4500-NH ₃ F-1997	4500-NH ₃ F-2011
4500-NH ₃ G-1997	4500-NH ₃ G-2011
4500-NH ₃ H-1997	4500-NH ₃ H-2011
4500-NO ₃ ⁻ D-2000	4500-NO ₃ ⁻ D-2011
4500-NO ₃ ⁻ E-2000	4500-NO ₃ ⁻ E-2011
4500-NO ₃ ⁻ F-2000	4500-NO ₃ ⁻ F-2011
4500-NO ₃ ⁻ H-2000	4500-NO ₃ ⁻ H-2011
4500NO ₂ ⁻ B-2000	4500NO ₂ ⁻ B-2011
4500-O B-2001	4500-O B-2011
4500-O C-2001	4500-O C-2011
4500-O D-2001	4500-O D-2011
4500-O E-2001	4500-O E-2011
4500-O F-2001	4500-O F-2011
4500-O G-2001	4500-O G-2011
4500-P B(5)-1999	4500-P B(5)-2011
4500-P E-1999	4500-P E-2011
4500-P F-1999	4500-P F-2011
4500-P G-1999	4500-P G-2011
4500-P H-1999	4500-P H-2011
4500-SiO ₂ C-1997	4500-SiO ₂ C-2011
4500-SiO ₂ E-1997	4500-SiO ₂ E-2011
4500-SiO ₂ F-1997	4500-SiO ₂ F-2011
4500-SO ₄ ²⁻ C-1997	4500-SO ₄ ²⁻ C-2011

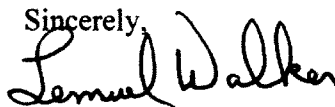
Table 1 (Continued)

4500-SO ₄ ²⁻ D-1997	4500-SO ₄ ²⁻ D-2011
4500-SO ₄ ²⁻ E-1997	4500-SO ₄ ²⁻ E-2011
4500-SO ₄ ²⁻ F-1997	4500-SO ₄ ²⁻ F-2011
4500-SO ₄ ²⁻ G-1997	4500-SO ₄ ²⁻ G-2011
4500-S ²⁻ B-2000	4500-S ²⁻ B-2011
4500-S ²⁻ C-2000	4500-S ²⁻ C-2011
4500-S ²⁻ D-2000	4500-S ²⁻ D-2011
4500-S ²⁻ F-2000	4500-S ²⁻ F-2011
4500-S ²⁻ G-2000	4500-S ²⁻ G-2011
4500-SO ₃ ²⁻ B-2000	4500-SO ₃ ²⁻ B-2011
5210 B-2001	5210 B-2011
5220 B-1997	5220 B-2011
5220 C-1997	5220 C-2011
5220 D-1997	5220 D-2011
5310 B-2000	5310 B-2011
5310 C-2000	5310 C-2011
5310 D-2000	5310 D-2011
5520 B-2001	5520 B-2011
5520 F-2001	5520 F-2011
5540 C-2000	5540 C-2011
6200 B-1997	6200 B-2011
6200 C-1997	6200 B-2011

For a method that is approved in more than one edition of a compendium an analyst must, at a minimum, follow the QA/QC in that edition. To improve consistency and ensure reliable results, laboratories are encouraged to phase-in and adopt the QA/QC procedures specified in the most recent, approved editions of that compendium.

We appreciate your interest in the development of environmental monitoring methods. If you have any questions regarding the review of these alternate test procedures, please contact me by e-mail at: walker.lemuel@epa.gov or by telephone at: 202-566-1077.

Sincerely,



Lemuel Walker

ATP Coordinator

Engineering and Analysis Division (4303 T)

Engineering and Analytical Support Branch



**METHOD 218.7: DETERMINATION OF HEXAVALENT
CHROMIUM IN DRINKING WATER BY ION
CHROMATOGRAPHY WITH POST-COLUMN
DERIVATIZATION AND UV-VISIBLE SPECTROSCOPIC
DETECTION**



**METHOD 218.7: DETERMINATION OF HEXAVALENT CHROMIUM IN DRINKING
WATER BY ION CHROMATOGRAPHY WITH POST-COLUMN
DERIVATIZATION AND UV-VISIBLE SPECTROSCOPIC DETECTION**

**Version 1.0
November 2011**

**A. Zaffiro and M. Zimmerman (Shaw Environmental, Inc.)
S. Wendelken, G. Smith and D. Munch (U.S. EPA, Office of Ground Water and Drinking Water)**

**TECHNICAL SUPPORT CENTER
STANDARDS AND RISK MANAGEMENT DIVISION
OFFICE OF GROUND WATER AND DRINKING WATER
U. S. ENVIRONMENTAL PROTECTION AGENCY
CINCINNATI, OHIO 45268**

METHOD 218.7

DETERMINATION OF HEXAVALENT CHROMIUM IN DRINKING WATER BY ION CHROMATOGRAPHY WITH POST-COLUMN DERIVATIZATION AND UV-VISIBLE SPECTROSCOPIC DETECTION

1. SCOPE AND APPLICATION

- 1.1 METHOD – Method 218.7 provides procedures for the determination of hexavalent chromium Cr(VI) as the chromate anion CrO_4^{2-} in finished drinking water using ion chromatography. Samples are analyzed by direct injection. This method is intended for use by analysts skilled in the operation of ion chromatographic instrumentation and in the interpretation of the associated data.

<u>Analyte</u>	<u>Chemical Abstracts Services Registry Number (CASRN)</u>
Hexavalent chromium (as CrO_4^{2-})	13907-45-4

1.2 SUPPORTING DATA

- 1.2.1 Single-laboratory method performance data, presented in Section 17, were collected using 4-mm i.d. anion exchange chromatographic columns designed for use with ammonium hydroxide/ammonium sulfate eluent systems and 4-mm i.d. columns designed for use with carbonate/bicarbonate eluent systems.
- 1.2.2 Precision and accuracy data have been generated for the analysis of Cr(VI) in reagent water and finished drinking water from both ground water and surface water sources (Sect. 17, Tables 4, 5 and 6).
- 1.2.3 Single laboratory Lowest Concentration Minimum Reporting Levels (LCMRLs) for Cr(VI) ranged from 0.012 to 0.036 microgram per liter ($\mu\text{g/L}$) (Section 17, Table 3). The LCMRL is the lowest spiking concentration such that the probability of spike recovery in the 50% to 150% range is at least 99%. The procedure used to determine the LCMRL is described elsewhere.¹ Laboratories using this method are not required to determine LCMRLs, but they must demonstrate that the Minimum Reporting Level (MRL) for Cr(VI) meets the requirements described in Section 9.2.4.
- 1.2.4 Determining a detection limit (DL) for Cr(VI) is optional (Sect. 9.2.6). The DL is defined as the statistically calculated minimum concentration that can be measured with 99% confidence that the reported value is greater than zero.² DLs for Cr(VI) fortified into reagent water ranged from 0.0044 to 0.015 $\mu\text{g/L}$ (Table 3).
- 1.3 METHOD FLEXIBILITY – The laboratory is permitted to modify chromatographic conditions including IC columns and eluent compositions different from those utilized in the method. Changes may not be made to sample collection and preservation (Sect. 8) or to the quality control (QC) requirements (Sect. 9). Method modifications should be considered

only to improve method performance. Modifications that are introduced in the interest of reducing cost or sample processing time, but result in poorer method performance, may not be used. In all cases where method modifications are proposed, the analyst must perform the procedures outlined in the Initial Demonstration of Capability (IDC, Sect. 9.2), and verify that all on-going QC acceptance criteria in this method (Section 9.3) are met, especially precision and accuracy in real sample matrixes.

2. **SUMMARY OF METHOD**³⁻⁶

Samples are preserved with a combined buffer/dechlorinating reagent which complexes free chlorine and increases the pH to a value greater than eight. A measured volume (usually 1 mL) of the sample is introduced into an ion chromatograph. CrO_4^{2-} is separated from other matrix components on an anion exchange column. CrO_4^{2-} is derivatized with 1,5-diphenylcarbazide in a post-column reactor and is detected spectrophotometrically at a wavelength of 530 nm. Cr(VI) is qualitatively identified via retention time, and the concentration of CrO_4^{2-} in the sample is calculated using the integrated peak area and the external standard technique. Results are reported in units of $\mu\text{g/L}$ of Cr(VI).

3. **DEFINITIONS**

- 3.1 ANALYSIS BATCH – A set of samples that is analyzed on the same instrument during a 24-hour period that begins and ends with the analysis of the appropriate Continuing Calibration Check (CCC) standards. Additional CCCs may be required depending on the length of the Analysis Batch and the number of field samples.
- 3.2 CALIBRATION STANDARD – A solution of Cr(VI), which includes the method preservative, prepared from the Primary Dilution Standards. The calibration standards are used to calibrate the instrument response with respect to analyte concentration.
- 3.3 CONTINUING CALIBRATION CHECK (CCC) – A calibration standard that is analyzed periodically to verify the accuracy of the existing calibration.
- 3.4 DETECTION LIMIT (DL) – The minimum concentration of Cr(VI) that can be identified, measured, and reported with 99% confidence that the concentration is greater than zero. This is a statistical determination (Sect. 9.2.6), and accurate quantitation is not expected at this level.
- 3.5 FIELD REAGENT BLANK (FRB) – An aliquot of reagent water that is placed in a sample container in the laboratory and treated as a sample in all respects, including shipment to the sampling site, exposure to sampling site conditions, storage, preservation, and all analytical procedures. The purpose of the FRB is to determine if Cr(VI) or other interferences are introduced into the samples during sampling, transport, and storage.
- 3.6 LABORATORY DUPLICATES (LDs) – Two sample aliquots (LD_1 and LD_2) taken in the laboratory from a single sample bottle, and analyzed separately with identical procedures. By cancelling variation contributed from sample collection, preservation, and storage

procedures, Laboratory Duplicates provide an estimate of precision associated specifically with the analytical determination.

- 3.7 LABORATORY FORTIFIED BLANK (LFB) – An aliquot of reagent water, containing the method preservative, to which a known quantity of Cr(VI) is added. The LFB is used during the IDC to verify method performance for precision and accuracy.
- 3.8 LABORATORY FORTIFIED SAMPLE MATRIX (LFSM) – An aliquot of a field sample to which a known quantity of Cr(VI) is added. The LFSM is processed and analyzed as a sample, and its purpose is to determine whether the sample matrix contributes bias to the analytical results.
- 3.9 LABORATORY FORTIFIED SAMPLE MATRIX DUPLICATE (LFSMD) – A second aliquot of the field sample used to prepare the LFSM which is fortified and analyzed identically to the LFSM. The LFSMD is used instead of the Laboratory Duplicate to assess method precision if Cr(VI) is absent from the sample matrix.
- 3.10 LABORATORY REAGENT BLANK (LRB) – An aliquot of reagent water that contains the method preservative. The LRB is used to determine if Cr(VI) or other interferences are introduced from the laboratory environment, the reagents or glassware, and to test for cross contamination.
- 3.11 LOWEST CONCENTRATION MINIMUM REPORTING LEVEL (LCMRL) – The single laboratory LCMRL is the lowest spiking concentration such that the probability of spike recovery in the 50% to 150% range is at least 99%.¹ LCMRL determinations from multiple laboratories can be used to develop a statistically derived MRL (Sect. 3.13).
- 3.12 MATERIAL SAFETY DATA SHEETS (MSDS) – Written information provided by vendors concerning a chemical's toxicity, health hazards, physical properties, fire and reactivity data, storage instructions, spill response procedures, and handling precautions.
- 3.13 MINIMUM REPORTING LEVEL (MRL) – The minimum concentration that can be reported by a laboratory as a quantified value for Cr(VI). This concentration must meet the criteria defined in Section 9.2.4 and must be no lower than the concentration of the lowest calibration standard. A laboratory may be required to demonstrate a specific MRL by a regulatory body if this method is being performed for compliance purposes.
- 3.14 POST-COLUMN REACTOR – For this method, the post-column reactor consists of a reagent delivery pump, a mixing tee, and a reaction coil.
- 3.15 PRIMARY DILUTION STANDARD (PDS) – An aqueous solution containing Cr(VI), which is prepared from a Stock Standard Solution. The PDS solution is diluted to prepare calibration standards and sample fortification solutions.

- 3.16 PROCEDURAL CALIBRATION – A calibration technique in which calibration standards are processed through the entire method, including sample preparation and addition of preservative.
- 3.17 QUALITY CONTROL SAMPLE (QCS) – A solution containing Cr(VI) at a known concentration that is obtained from a source external to the laboratory and different from the source of calibration standards. The purpose of the QCS is to verify the accuracy of the primary calibration standards.
- 3.18 REAGENT WATER – Purified water that does not contain any measurable quantity of Cr(VI) or interfering compounds at or above one-third the MRL.
- 3.19 STOCK STANDARD SOLUTION – A concentrated standard solution that is prepared in the laboratory using assayed reference materials, or that is purchased from a commercial source with a certificate of analysis.

4. INTERFERENCES

- 4.1 LABWARE – The stability of Cr(VI) was demonstrated for this method using high-density polyethylene (HDPE) sample bottles. Polypropylene copolymer bottles are also acceptable. Aliquots of the PDS and sample fortification solutions were transferred using polypropylene pipette tips. Other types of sample bottles may be used; however, the laboratory must confirm the stability of Cr(VI) in these materials over 14 days by formal experiment.
- 4.2 REAGENTS AND EQUIPMENT – Method interferences may be caused by contaminants in reagents (including the method preservative) and in the ion chromatographic system. All laboratory reagents and instruments must be routinely demonstrated to be free from interferences, and to contribute less than one-third the MRL for Cr(VI), under the conditions of the analysis. This may be accomplished by analyzing LRBs, as described in Section 9.3.1.
- 4.3 MATRIX INTERFERENCES – Matrix interferences are caused by contaminants that are present in the sample. The extent of matrix interferences will vary considerably from source to source, depending upon the nature of the water. Matrix components may directly interfere by producing a signal at or near the retention time of the Cr(VI) peak; however, the method is extremely selective due to the chromatographic separation of the analyte from matrix components, coupled with the discrimination of the post-column reagent for the chromate anion. Sample ionic strength may enhance or suppress Cr(VI) response; however, the 4-mm column systems used during method development tolerate typical concentrations of common anions in drinking water in combination with method preservative. Acceptable method performance has been demonstrated for samples with hardness up to 350 mg/L as CaCO₃ and total organic carbon content of 3 mg/L. The analysis of Laboratory Fortified Sample Matrix (Sect. 9.3.4) provides the user of the method with evidence for the presence (or absence) of matrix effects.
- 4.4 OXIDATION-REDUCTION (REDOX) CONCERNS – To ensure sample integrity, Cr(VI) must be protected from reduction, and Cr(III), if present, must not oxidize to Cr(VI) during

sample storage. Within the normal pH range in drinking water, Cr(VI), present as a result of pollution or oxidation of Cr(III) in source water during treatment, forms oxyanions, which are typically represented as HCrO_4^- and CrO_4^{2-} . The very stable CrO_4^{2-} anion dominates above pH 7⁸; therefore, the method preservative is designed to buffer samples to at least pH 8. Chromate compounds are quite soluble, mobile and stable, particularly in an oxidizing environment.⁸ In contrast, soluble Cr(III) species oxidize to Cr(VI) in the presence of free chlorine⁹, although natural organic matter in surface water sources may complex Cr(III), slowing its oxidation even in a highly oxidizing environment.⁷ The rate of Cr(III) oxidation increases with chlorine concentration and is pH-dependent.⁷ For these reasons, both preservation options prescribed in this method include ammonium ions to complex free chlorine. The resulting formation of chloramines minimizes, but does not completely prevent, the oxidation of Cr(III).⁷ During method development, experiments were conducted that demonstrated the ability of the method preservative to minimize the oxidation of Cr(III) and to prevent the reduction of Cr(VI) for at least 14 days in drinking water from ground and surface water sources. Representative study results for a surface water source are presented in Section 17, Table 7.

5. SAFETY

- 5.1 Each chemical should be treated as a potential health hazard and exposure to these chemicals should be minimized. Each laboratory is responsible for maintaining an awareness of OSHA regulations regarding safe handling of chemicals used in this method. A reference file of MSDSs should be made available to all personnel involved in the chemical analysis. Hexavalent chromium in solid form presents an inhalation hazard, is toxic and a suspected carcinogen. All forms of hexavalent chromium should be handled with appropriate precautions. A fact sheet on the health effects of hexavalent chromium in the workplace is available on the OSHA website @ www.osha.gov.
- 5.2 Preparation of the post-column reagent and the ammonium hydroxide preservative require the use of concentrated acid and concentrated base. These reagents should be prepared in a hood, adding acid to water, and wearing splash goggles with chemical resistant gloves. Gloves and splash goggles should be worn when transferring the post-column reagent to the instrument reservoir.

6. EQUIPMENT AND SUPPLIES

References to specific brands or catalog numbers are included as examples only and do not imply endorsement of the product. Such reference does not preclude the use of other vendors or suppliers.

- 6.1 SAMPLE CONTAINERS – 125-ml, wide-mouth, high-density polyethylene (HDPE) (Fisher Scientific Cat. No. 02-911-958 or equivalent); 125-mL polypropylene copolymer (Fisher Scientific Cat. No. 02-893-A or equivalent).
- 6.2 AUTOSAMPLER VIALS – Size and material meeting vendor specification for the ion chromatograph. Polypropylene and polystyrene are commonly used for ion chromatography.

- 6.3 AUTOMATIC PIPETTE – (Eppendorf Research Pro or equivalent). An automatic pipette with polypropylene tips is recommended for preparing all standard solutions and for fortifying QC samples.
- 6.4 ANALYTICAL BALANCE – Capable of weighing to the nearest 0.0001 gram (g).
- 6.5 ION CHROMATOGRAPHY SYSTEM WITH POST-COLUMN REACTOR
- 6.5.1 IC SYSTEM – An analytical system consisting of an autosampler, pump module with vacuum degassing option, sample loop, guard column, anion separator column, post-column reagent addition capability, post-column reaction coil, UV–Vis absorbance detector set to monitor a wavelength of 530 nm, and a data acquisition and management system. The system must not contain any metal parts in the sample, eluent and reagent flow paths.
- 6.5.2 SAMPLE LOOP – Polyetheretherketone (PEEK) construction and sized for the column system. One- and 1.25-mL sample loops were used to generate the performance data presented in this method. Smaller or larger injection volumes may be used as long as the Initial Demonstration of Capability (Sect. 9.2), calibration, and sample analyses are performed using the same injection volume. The laboratory must be able to meet the MRL verification criteria (Section 9.2.4) using the selected injection volume.
- 6.5.3 GUARD COLUMN – Size and resin per vendor specification; capable of removing strongly adsorbing organic compounds and particles that could damage the analytical column.
- 6.5.4 ANALYTICAL COLUMN – Anion exchange column capable of resolving the chromate anion from matrix components. Any column that provides adequate resolution, peak shape, capacity, accuracy and precision (Sect. 9), and does not result in suppression or enhancement of analyte response (Sect. 4.3) may be used.
- 6.5.5 COLUMN COMPARTMENT – Temperature controlled recommended.
- 6.5.6 POST-COLUMN REACTOR– Pneumatic or mechanical reagent pump capable of pulse-free operation, mixing tee, and reaction coil (sized and configured per vendor specifications).
- 6.5.7 DATA SYSTEM – An interfaced data system is required to acquire, store, and output data. The computer software must have the capability of processing stored data by recognizing and integrating a chromatographic peak within a given retention time window. The software must be able to construct a linear regression or quadratic regression calibration curve and calculate the Cr(VI) concentration using the external standard technique.

7. REAGENTS AND STANDARDS

- 7.1 REAGENTS AND SOLVENTS – Reagent grade or better chemicals must be used. Unless otherwise indicated, it is intended that all reagents will conform to the specifications of the Committee on Analytical Reagents of the American Chemical Society (ACS), where such specifications are available. Other grades may be used if the reagent is demonstrated to be free of Cr(VI) and other interferences, and all requirements of the IDC are met when using these reagents.
- 7.1.1 AMMONIUM HYDROXIDE (NH_4OH , CASRN 1336-21-6) – 28-30% NH_3 w/w (Fisher Cat. No. AC42330 or equivalent). For preparing $\text{NH}_4\text{OH}/(\text{NH}_4)_2\text{SO}_4$ (liquid) preservative and IC eluent.
- 7.1.2 AMMONIUM SULFATE [$(\text{NH}_4)_2\text{SO}_4$, CASRN 7783-20-2] (Sigma-Aldrich Cat. No. A4915 or equivalent). For preparing $\text{NH}_4\text{OH}/(\text{NH}_4)_2\text{SO}_4$ (liquid) preservative, $\text{CO}_3^{2-}/\text{HCO}_3^-/(\text{NH}_4)_2\text{SO}_4$ (solid) preservative, and IC eluent.
- 7.1.3 METHANOL (CH_3OH , CASRN 67-56-1) – (Fisher Optima® LC/MS grade or equivalent). For preparing the post-column reagent.
- 7.1.4 SODIUM BICARBONATE (NaHCO_3 , CASRN 144-55-8) – for preparing $\text{CO}_3^{2-}/\text{HCO}_3^-/(\text{NH}_4)_2\text{SO}_4$ (solid) preservative and IC eluent.
- 7.1.5 SODIUM CARBONATE (Na_2CO_3 , CASRN 497-19-8) – Anhydrous. For preparing $\text{CO}_3^{2-}/\text{HCO}_3^-/(\text{NH}_4)_2\text{SO}_4$ (solid) preservative and IC eluent.
- 7.1.6 REAGENT WATER – Distilled or deionized water. For preparing calibration standards and reagents.
- 7.1.7 1,5-DIPHENYLCARBAZIDE ($\text{C}_{13}\text{H}_{14}\text{N}_4\text{O}$, CASRN 140-22-7) – for preparing the post-column reagent.
- 7.1.8 SULFURIC ACID (H_2SO_4 , CASRN 7664-93-9) – 93 to 98 percent, trace metal grade (Fisher Cat. No. A510 or equivalent). For preparing the post-column reagent.
- 7.1.9 PREPARATION OF POST-COLUMN REAGENT – 2-mM 1,5-diphenylcarbazide, 10% methanol and 0.5 M (1 N) sulfuric acid. Add 28 mL of sulfuric acid to approximately 500 mL of reagent water in a 1-liter volumetric flask or suitably sized bottle. Mix and cool to room temperature in a water bath. While this solution is cooling, weigh 0.50 gram of 1,5-diphenylcarbazide into a 100-mL beaker, add 75 mL of methanol, and sonicate for five minutes to dissolve the solid. Transfer this solution to a 100-mL volumetric flask; bring to volume with methanol and mix. Add the entire contents of the volumetric flask to the sulfuric acid solution and dilute to 1.0 L with reagent water. Mix and transfer the solution to the post-column reagent reservoir. Method 218.7 was developed adhering to a schedule for replacing post-column reagent five days after the

original date of preparation. Users of this method must determine when this reagent should be replaced based on the recommendations of the instrument manufacturer, and on the ability to meet the QC requirements in Section 9.

- 7.1.10 PREPARATION OF $\text{CO}_3^{2-}/\text{HCO}_3^-/(\text{NH}_4)_2\text{SO}_4$ (SOLID) PRESERVATIVE – Nominally 13.3 mg Na_2CO_3 , 10.5 mg NaHCO_3 and 33 mg $(\text{NH}_4)_2\text{SO}_4$. These are the appropriate amounts for a 100-mL sample. Weigh 1–1.25 times these values and transfer to a dry, 125-mL sample bottle.
- 7.1.11 PREPARATION OF $\text{NH}_4\text{OH}/(\text{NH}_4)_2\text{SO}_4$ (LIQUID) PRESERVATIVE – Dissolve 3.3 g $(\text{NH}_4)_2\text{SO}_4$ in 75 mL of reagent water. Add 6.5 mL ammonium hydroxide and dilute to 100-mL final volume. During method development, the stability of the concentrated preservative was verified for one month when stored at ambient temperature. Laboratories using this method are required to determine when this reagent should be replaced.
- 7.1.12 PREPARATION OF COLUMN ELUENTS – Representative column eluent systems are listed in Section 17, Tables 1 and 2. Eluent solutions of these types should be prepared on a weekly basis or at intervals recommended by the instrument manufacturer.
- 7.2 STANDARD SOLUTIONS – Solution concentrations listed in this section were used to develop this method and are included only as examples. Guidance on the storage stability of Primary Dilution Standards and calibration standards is provided in the applicable sections below. Although estimated stability times for standard solutions are given, laboratories should use standard QC practices to determine appropriate storage conditions and when standards need to be replaced.
- 7.2.1 ANALYTE STOCK STANDARD SOLUTION (1000 $\mu\text{g/mL}$) – Prepare from neat material (ACS reagent grade, >99% purity) in reagent water or obtain Cr(VI) as a certified solution in water (e.g., Ultra Cat. No. ICP-024A, AccuStandard Cat. No. WC-HEX-10X-1 or equivalent). For $\text{K}_2\text{Cr}_2\text{O}_7$ starting material, dry the salt at 100 °C to a constant weight; weigh 0.283 g, dissolve in reagent water, and dilute to 100 mL. Store stock standards at room temperature.
- 7.2.1.1 ANALYTE PRIMARY DILUTION STANDARD (Analyte PDS) (1000 $\mu\text{g/L}$) – Prepare the Analyte PDS by diluting the Analyte Stock Standard solution (1:1000) into reagent water. Include the same preservative used for field samples. An example preparation of Analyte PDS solutions (those used to collect data presented in Section 17) is provided in the table below. Store the PDS in a 125-mL HDPE or polypropylene bottle. The Analyte PDS is used to prepare calibration standards and to fortify QC samples with Cr(VI).

Stock Concentration	Aliquot of Stock Standard Solution (7.2.1, 1000 µg/mL)	Preservative Amounts	Volume Reagent Water	PDS Concentration
1000 µg/mL with NH ₄ OH/(NH ₄) ₂ SO ₄ (liquid) preservative	0.10 mL	1 mL preservative (Sect. 7.1.11)	0.10 L	1000 µg/L
1000 µg/mL with solid preservative	0.10 mL	13.3 mg Na ₂ CO ₃ , 10.5 mg NaHCO ₃ 33 mg (NH ₄) ₂ SO ₄	0.10 L	1000 µg/L

Storage stability of the Analyte PDS was verified during method development. The Analyte PDS was stable for at least 14 days when stored at room temperature.

7.2.2 CALIBRATION STANDARDS (CALs) – Prepare a series of calibration standards (at least six levels) by diluting the Analyte PDS into reagent water. Include the same preservative used for field samples. The lowest calibration standard must be at or below the concentration of the MRL (Sect. 9.2.4). The calibration standards may also be used as CCCs. An example preparation of calibration standards (starting with the Analyte PDS) used to collect method performance data is provided in the table below.

Dilution Aliquot	Starting Concentration (µg/L)	Final Volume (L)	Final Concentration (µg/L)
0.50 mL Analyte PDS	1000	0.10	5.0
0.10 mL Analyte PDS	1000	0.10	1.0
10 mL 5.0 µg/L CAL	5.0	0.10	0.50
5.0 mL 5.0 µg/L CAL	5.0	0.10	0.25
2.0 mL 5.0 µg/L CAL	5.0	0.10	0.10
1.0 mL 5.0 µg/L CAL	5.0	0.10	0.050
0.4 mL 5.0 µg/L CAL	5.0	0.10	0.020

Storage stability of the calibration standards was evaluated during method development at concentrations between 0.020 µg/L and 1.0 µg/L. The calibration solutions were stable for at least 14 days when stored at 4 °C.

8. SAMPLE COLLECTION, PRESERVATION AND STORAGE

8.1 ADDITION OF PRESERVATIVE –The samples are preserved with a combined buffer/dechlorinating reagent. Either the liquid formulation or the solid formulation of the preservative described in the following sections may be used. Only one preservative formulation should be used (liquid or solid) to prepare the sample bottles.

8.1.1. LIQUID FORMULATION - NH₄OH/(NH₄)₂SO₄ – The liquid preservative may be added to sample bottles prior to shipment. Apply the concentrated preservative (Sect. 7.1.11) at the rate of 1 mL per 100 mL of sample. Sample bottles prepared in advance may be stored for one month prior to use.

- 8.1.2. **SOLID FORMULATION - $\text{CO}_3^{2-}/\text{HCO}_3^-/(\text{NH}_4)_2\text{SO}_4$** – The solid preservative may be added to sample bottles prior to shipment. Add 13.3 mg Na_2CO_3 , 10.5 mg NaHCO_3 and 33 mg $(\text{NH}_4)_2\text{SO}_4$ to each bottle following the instructions in Section 7.1.10.
- 8.2 **SAMPLE COLLECTION** – Open the tap and allow the system to flush for approximately 5 minutes. Fill sample bottles with 100-mL of sample, taking care not to flush out the preservative. Invert the bottle several times to mix the sample with the preservative.
- 8.3 **SAMPLE SHIPMENT AND STORAGE** – Storage stability studies have demonstrated that samples are stable for at least 14 days at both ambient temperature (25 °C) and chilled temperature (6 °C). If the anticipated shipping conditions would expose the samples to temperature extremes, samples may be chilled during shipment. Standard quality control practices should be put in place to confirm that the shipping conditions do not adversely affect sample stability. A laboratory fortified sample that is shipped with the sample kit can aid in making this determination. Upon sample receipt, measure the free chlorine and sample pH. The free chlorine concentration must be less than 0.1 mg/L and the pH must be >8 for the sample to be valid. In the laboratory, it is recommended that the samples are stored at or below 6 °C until analysis.
- 8.4 **SAMPLE HOLDING TIMES** – Results of the sample storage stability study (Table 7) indicate that Cr(VI) is stable for at least 14 days when collected, preserved, shipped and stored as described in Sections 8.1 to 8.3. Samples should be analyzed as soon as possible, but must be analyzed within 14 days.

9. **QUALITY CONTROL**

- 9.1 QC requirements include the IDC and ongoing QC requirements. This section describes each QC parameter, its required frequency, and the performance criteria that must be met. The QC criteria discussed in the following sections are summarized in Section 17, Tables 8 and 9. These QC requirements are considered the minimum acceptable QC program. Laboratories are encouraged to institute additional QC practices to meet their specific needs.
- 9.2 **INITIAL DEMONSTRATION OF CAPABILITY (IDC)** – The IDC must be successfully performed prior to analyzing any field samples. The IDC must be repeated if changes are made to analytical parameters not previously validated during the IDC, for example, changing from $\text{NH}_4\text{OH}/(\text{NH}_4)_2\text{SO}_4$ preservative to the $\text{CO}_3^{2-}/\text{HCO}_3^-/(\text{NH}_4)_2\text{SO}_4$ preservative or translating the method to a 2-mm column system. Prior to conducting the IDC, the analyst must meet the calibration requirements outlined in Section 10.2.
- 9.2.1 **DEMONSTRATION OF LOW SYSTEM BACKGROUND** – Analyze an LRB after the analysis of the highest concentration calibration standard. Confirm that the blank is free of contamination as defined in Section 9.3.1.
- 9.2.2 **DEMONSTRATION OF PRECISION** – Prepare and analyze seven replicate LFBs. Fortify these samples near the midrange of the initial calibration curve. The method

preservative must be added to the LFBs as described in Section 8. The percent relative standard deviation (%RSD) of the concentrations of the replicate analyses must be $\leq 15\%$.

$$\% \text{ RSD} = \frac{\text{Standard Deviation of Measured Concentrations}}{\text{Average Concentration}} \times 100$$

- 9.2.3 DEMONSTRATION OF ACCURACY – Using the same set of replicate data generated for Section 9.2.2, calculate the average percent recovery. The average percent recovery for Cr(VI) must be within $\pm 15\%$ of the true value.

$$\% \text{ Recovery} = \frac{\text{Average Measured Concentration}}{\text{Fortified Concentration}} \times 100$$

- 9.2.4 MINIMUM REPORTING LEVEL (MRL) CONFIRMATION – Establish a target concentration for the MRL based on the intended use of the method. Analyze an initial calibration following the procedures in Section 10. The lowest calibration standard used to establish the initial calibration (as well as the low-level CCC) must be at or below the concentration of the MRL. Establishing the MRL concentration too low may cause repeated failure of ongoing QC requirements. Confirm the MRL following the procedure outlined below.

- 9.2.4.1 Fortify and analyze seven replicate LFBs at or below the proposed MRL concentration. The LFBs must contain the method preservative as specified in Section 8. Calculate the mean (*Mean*) and standard deviation for these replicates. Determine the Half Range for the Prediction Interval of Results (HR_{PIR}) using the equation

$$HR_{PIR} = 3.963S$$

where S is the standard deviation and 3.963 is a constant value for seven replicates.¹

- 9.2.4.2 Confirm that the Upper and Lower limits for the Prediction Interval of Results ($PIR = \text{Mean} \pm HR_{PIR}$) meet the upper and lower recovery limits as shown below.

The Upper PIR Limit must be $\leq 150\%$ percent recovery.

$$\frac{\text{Mean} + HR_{PIR}}{\text{Fortified Concentration}} \times 100 \leq 150\%$$

The Lower PIR Limit must be $\geq 50\%$ percent recovery.

$$\frac{\text{Mean} - HR_{PIR}}{\text{Fortified Concentration}} \times 100 \geq 50\%$$

- 9.2.4.3 The MRL is valid if both the Upper and Lower PIR Limits meet the criteria described above. If these criteria are not met, the MRL has been set too low and must be confirmed again at a higher concentration.

NOTE: These equations are only valid for seven replicate samples.

- 9.2.5 QUALITY CONTROL SAMPLE (QCS) – Analyze a mid-level Quality Control Sample (Sect. 9.3.6) to confirm the accuracy of the primary calibration standards.
- 9.2.6 DETECTION LIMIT DETERMINATION (*optional*) – *While DL determination is not a specific requirement of this method, it may be required by various regulatory bodies associated with compliance monitoring. It is the responsibility of the laboratory to ascertain whether DL determination is required based upon the intended use of the data.*

The DL, as defined for this method, is an MDL² with the additional requirement that the analyses for the procedure must be performed over at least three days. Prepare at least seven replicate LFBs at a concentration estimated to be near the DL. This concentration may be estimated by selecting a concentration at two to five times the noise level. The method preservative must be added to the samples as described in Section 8. Process the seven replicates through all steps of Section 11. Do not subtract blank values when performing DL calculations.

NOTE: If an MRL confirmation data set meets these requirements, a DL may be calculated from the MRL confirmation data, and no additional analyses are necessary.

Calculate the DL using the following equation:

$$DL = s \times t_{(n-1, 1-\alpha = 0.99)}$$

where

$t_{(n-1, 1-\alpha = 0.99)}$ = Student's t value for the 99% confidence level with $n-1$ degrees of freedom (for seven replicate determinations, the Student's t value is 3.143 at a 99% confidence level),

n = number of replicates, and

s = standard deviation of replicate analyses.

- 9.3 ONGOING QC REQUIREMENTS – This section describes the ongoing QC elements that must be included when processing and analyzing field samples.

- 9.3.1 LABORATORY REAGENT BLANK (LRB) – Analyze an LRB during the IDC and with each Analysis Batch. Prepare the LRB by adding reagent water to a sample bottle representative of those used to collect the samples, preferably from the same sample kit. The LRB must contain the sample preservative. Cr(VI), or contaminants that produce a signal overlapping with the Cr(VI) peak, must be less than one-third the MRL. If Cr(VI) is detected in the LRB at concentrations equal to or greater than this level, then all

samples analyzed in the corresponding Analysis Batch are invalid. Subtracting blank values from sample results is not permitted.

- 9.3.2 CONTINUING CALIBRATION CHECK (CCC) – Analyze CCC standards at the beginning of each Analysis Batch, after every ten field samples, and at the end of the Analysis Batch. See Section 10.3 for concentration requirements and acceptance criteria for CCCs. Additional guidance on sequencing proper Analysis Batches is provided in Section 11.2.
- 9.3.3 LABORATORY FORTIFIED BLANK (LFB) – Because this method utilizes procedural calibration standards, which are fortified reagent waters, there is no difference between the LFB and the Continuing Calibration Check standard. Consequently, the analysis of a separate LFB is not required as part of the ongoing QC; however, the term “LFB” is used for clarity in the IDC.
- 9.3.4 LABORATORY FORTIFIED SAMPLE MATRIX (LFSM) – Within each Analysis Batch, analyze a minimum of one LFSM. The background concentration of Cr(VI) in the sample matrix must be determined in a separate aliquot and subtracted from the measured value in the LFSM. If various sample matrixes are analyzed regularly, for example, drinking water processed from ground water and surface water sources, performance data should be collected for each source.
- 9.3.4.1 Prepare the LFSM by fortifying a sample with an appropriate amount of the Analyte PDS (Sect. 7.2.1.1). Generally, select a spiking concentration that is greater than or equal to the native concentration of Cr(VI). If the native concentration does not allow this criterion to be met without exceeding the calibration range, dilution with reagent water containing the method preservative is permitted. Selecting a duplicate aliquot of a sample that has already been analyzed aids in the selection of an appropriate spiking level. If this is not possible, use historical data when selecting a fortifying concentration.
- 9.3.4.2 Calculate the percent recovery (%R) using the equation:

$$\%R = \frac{(A - B)}{C} \times 100$$

where

A = measured concentration in the fortified sample,

B = measured concentration in the unfortified sample, and

C = fortification concentration.

- 9.3.4.3 Cr(VI) recovery for samples fortified at concentrations near or at the MRL (within a factor of two times the MRL concentration) must be within $\pm 50\%$ of the true value. Recovery for samples fortified at all other concentrations must be within $\pm 15\%$ of the true value. If the accuracy falls outside the designated range, and the laboratory performance is shown to be in control in the CCCs, the recovery is judged matrix biased. Report the result in the unfortified sample as “suspect/matrix.”

NOTE: In order to obtain meaningful percent recovery results, correct the measured value in the LFSM and LFSMD for the native level in the unfortified samples, even if the native value is less than the MRL. This is the only time that values below the MRL may be used for calculations.

9.3.5 LABORATORY DUPLICATE OR LABORATORY FORTIFIED SAMPLE MATRIX DUPLICATE (LD or LFSMD) – Within each Analysis Batch, analyze a minimum of one Laboratory Duplicate or one Laboratory Fortified Sample Matrix Duplicate. If Cr(VI) is not routinely observed in field samples, analyze an LFSMD rather than an LD.

9.3.5.1 Calculate the relative percent difference (RPD) for duplicate measurements (LD1 and LD2) using the equation:

$$RPD = \frac{|LD_1 - LD_2|}{(LD_1 + LD_2)/2} \times 100$$

9.3.5.2 RPDs for Laboratory Duplicates must be $\leq 15\%$. Greater variability may be observed when Laboratory Duplicates have Cr(VI) concentrations that are near or at the MRL (within a factor of two times the MRL concentration). At these concentrations, Laboratory Duplicates must have RPDs that are $\leq 50\%$. If the RPD falls outside the designated range, and the laboratory performance is shown to be in control in the CCC, the precision is judged matrix influenced. Report the result in the unfortified sample as “suspect/matrix.”

9.3.5.3 If an LFSMD is analyzed instead of a Laboratory Duplicate, calculate the RPD for the LFSM and LFSMD using the equation:

$$RPD = \frac{|LFSM - LFSMD|}{(LFSM + LFSMD)/2} \times 100$$

9.3.5.4 RPDs for duplicate LFSMs must be $\leq 15\%$. Greater variability may be observed when the matrix is fortified near or at the MRL (within a factor of two times the MRL concentration). LFSMs at these concentrations must have RPDs that are $\leq 50\%$. If the RPD falls outside the designated range, and the laboratory performance is shown to be in control in the CCC, the precision is judged matrix influenced. Report the result in the unfortified sample as “suspect/matrix.”

9.3.6 QUALITY CONTROL SAMPLE (QCS) – A QCS must be analyzed during the IDC, and then each time new calibration standards are prepared. Prepare the QCS near the midpoint of the calibration range. The acceptance criterion for the QCS is 85 to 115% of the true value. If the accuracy for Cr(VI) fails the recovery criterion, prepare fresh standard dilutions and repeat the QCS evaluation.

10. CALIBRATION AND STANDARDIZATION

Demonstration and documentation of initial analyte calibration are required before performing the IDC and prior to analyzing field samples. The initial calibration must be repeated each time a major instrument modification or maintenance is performed.

10.1 OPTIMIZATION

10.1.1 ION CHROMATOGRAPHY INSTRUMENT CONDITIONS – IC operating conditions and columns used to collect method performance data are given in Section 17, Tables 1 and 2. Conditions different from these (e.g., IC columns and eluent systems) may be used if the QC criteria in Sections 9.2 and 9.3 are met, and chromatographic precision and accuracy is demonstrated within each Analysis Batch and for representative sample matrixes.

10.1.2 POST-COLUMN REAGENT DELIVERY CONDITIONS – Representative conditions for reaction coil volume and post-column reagent flow rates are provided in Section 17, Tables 1 and 2. Select conditions that provide the best signal-to-noise values for Cr(VI) at concentrations near the MRL.

10.1.3 UV-Vis DETECTOR – Monitor wavelength 530 nm.

10.2 INITIAL CALIBRATION

10.2.1 CALIBRATION STANDARDS – Prepare a set of calibration standards (at least six levels) as described in Section 7.2.2. The Cr(VI) concentration in the lowest calibration standard must be at or below the MRL. Field samples must be quantified using a calibration curve that spans the same concentration range used to collect the IDC data (Sect. 9.2); i.e., analysts are not permitted to use a restricted calibration range to meet the IDC criteria and then use a larger dynamic range during analysis of field samples.

10.2.2 CALIBRATION – Calibrate the IC system using the Cr(VI) peak area and the external standard technique. Fit the calibration points with either a linear regression or quadratic regression (response vs. concentration). Weighting may be used. Forcing the calibration curve through the origin is not recommended. The IC instruments used during method development were calibrated using inverse concentration-weighted linear curves.

10.2.3 CALIBRATION ACCEPTANCE CRITERIA – Validate the initial calibration by calculating the concentration of Cr(VI) using the regression equations for each of the standard runs used to generate the calibration curve. For calibration levels that are \leq MRL, the result should be within $\pm 50\%$ of the true value. Cr(VI) concentrations in other calibration levels should calculate to be within $\pm 15\%$ of the true value. If these criteria cannot be met, the analyst may have difficulty meeting ongoing QC criteria. Corrective action is recommended, such as reanalyzing the calibration standards, restricting the range of calibration, or performing instrument maintenance.

- 10.3 CONTINUING CALIBRATION CHECKS (CCCs) – Analyze a CCC to verify the initial calibration at the beginning of each Analysis Batch, after every tenth field sample, and at the end of each Analysis Batch. The beginning CCC for each Analysis Batch must be at or below the MRL. This CCC verifies instrument sensitivity prior to the analysis of samples. Alternate subsequent CCCs between the remaining calibration levels.
- 10.3.1 Calculate the concentration of Cr(VI) in the CCC. Calibration standards fortified at a level \leq MRL must calculate to be within $\pm 50\%$ of the true value. The calculated concentration in CCCs fortified at all other levels must be within $\pm 15\%$. If these limits are exceeded, then all samples analyzed since the last acceptable CCC are invalid. Re-analyze these samples, providing they are still within holding time, after an acceptable calibration has been restored.
- 10.4 REMEDIAL ACTION – Failure to meet CCC QC performance criteria requires remedial action. Acceptable method performance may be restored simply by preparing fresh post-column reagent and eluent followed by flushing the column and reaction coil for an extended period. Following this and other minor remedial action, check the calibration with a mid-level CCC and a CCC at the MRL, or alternatively recalibrate according to Section 10.2. If calibration failures persist, maintenance may be required such as replacing the guard column, analytical column or reaction coil. These latter measures constitute major maintenance, and the analyst must return to the initial calibration step (Sect. 10.2) and verify sensitivity by analyzing a CCC at or below the MRL.

11. PROCEDURE

This section describes the procedures for sample preparation and analysis. Important aspects of this analytical procedure include proper sample collection and storage (Sect. 8), ensuring that the instrument is properly calibrated (Sect. 10), and that all required QC elements are included (Sect. 9). All field, QC, and calibration samples including the LRB must be preserved as described in Section 8.

11.1 SAMPLE ANALYSIS

- 11.1.1 Establish IC operating and post-column reagent delivery conditions per the guidance in Section 10.1.
- 11.1.2 Flush the column, start the post-column reagent delivery pump, warm up the UV-Vis detector, and take other steps necessary to stabilize the IC system prior to beginning each analysis sequence. This step is especially important if the system has been idle for an extended period.
- 11.1.3 Establish a valid initial calibration following the procedures in Section 10.2 or confirm that the existing calibration is still valid by analyzing a low-level CCC (Sect. 10.3). Analyze field and QC samples in a properly sequenced Analysis Batch as described in Section 11.2.

11.2 THE ANALYSIS BATCH – An Analysis Batch is a sequence of samples, analyzed within a 24-hour period of no more than 20 field samples that includes all required QC samples (LRB, CCCs, LFSMs and LFSMDs or LDs). The required QC samples are not included in counting the maximum field sample total of 20. Dilutions are counted as samples. The purpose of the 20-sample limit is to ensure that a low-level CCC and an LRB are repeated on a regular and frequent basis. Analytical conditions for the Analysis Batch must be the same as those applied during calibration.

11.2.1 After a valid calibration curve is established, begin every Analysis Batch by analyzing an initial low-level CCC at or below the MRL. This initial CCC must be within $\pm 50\%$ of the true value. Continue the Analysis Batch by analyzing an LRB, followed by field and QC samples at appropriate frequencies (Section 9.3). Analyze and rotate between a mid- and a high-level CCC after every ten field samples and at the end each Analysis Batch. Do not count QC samples (LRBs, LDs, LFSMs, LFSMDs) when calculating the required frequency of CCCs. After 20 field samples or 24 hours, the low-level CCC and LRB must be repeated to begin a new Analysis Batch.

11.2.2 The close-out CCC completes the Analysis Batch. The acquisition start time of the closeout CCC must be within 24 hours of the acquisition start time of the low-level CCC at the beginning of the Analysis Batch. More than one Analysis Batch within a 24-hour period is permitted.

12. DATA ANALYSIS AND CALCULATIONS

12.1 For each Analysis Batch, establish an appropriate retention time window to identify Cr(VI). Base this assignment on measurements of actual retention time variation for Cr(VI) in standard solutions over the course of time. The suggested variation is plus or minus three times the standard deviation of the retention time for a series of injections. The injections from the initial calibration and from the IDC (Sect. 9.2) may be used to calculate the retention time window. However, the experience of the analyst should weigh heavily on the determination of an appropriate range.

12.2 At the conclusion of data acquisition, use the same software settings established during the calibration procedure to identify Cr(VI) in the predetermined retention time window. Confirm the identity by comparison of the retention time with that of the corresponding Cr(VI) peak in an initial calibration standard or CCC.

12.3 Calculate the Cr(VI) concentration using the multipoint calibration established in Section 10.2. Report only those values that fall between the MRL and the highest calibration standard.

12.4 Calculations must use all available digits of precision, but final reported concentrations should be rounded to an appropriate number of significant figures (one digit of uncertainty), typically two, and not more than three significant figures.

- 12.5 Prior to reporting the data, the chromatograms must be reviewed for incorrect peak identification or improper integration. The laboratory is responsible for ensuring that QC requirements have been met and that any appropriate qualifier is assigned.
- 12.6 The analyst must not extrapolate beyond the established calibration range. If the Cr(VI) result exceeds the range of the initial calibration curve, the sample may be diluted using reagent water containing the method preservative. Re-inject the diluted sample. Incorporate the dilution factor into final concentration calculations. The resulting data must be annotated as a dilution, and the reported MRL must reflect the dilution factor.

13. METHOD PERFORMANCE

- 13.1 PRECISION, ACCURACY AND DETECTION LIMITS – Single laboratory method performance data are presented in Section 17. LCMRLs and DLs for both $\text{NH}_4\text{OH}/(\text{NH}_4)_2\text{SO}_4$ preservative and the $\text{CO}_3^{2-}/\text{HCO}_3^-/(\text{NH}_4)_2\text{SO}_4$ preservative are presented in Table 3. Precision and accuracy data are presented for Cr(VI) fortified into reagent water and preserved with $\text{NH}_4\text{OH}/(\text{NH}_4)_2\text{SO}_4$ (Table 4). These data were collected using columns designed for use with an ammonium hydroxide/ammonium sulfate eluent system and columns designed for use with a carbonate/bicarbonate eluent system. Precision and accuracy data are presented for Cr(VI) fortified into two sources of chlorinated ground water, a chlorinated surface water finished with granular activated carbon (GAC) filtration, and a chlorinated surface water finished without GAC filtration. These data were collected using columns designed for an ammonium hydroxide/ammonium sulfate eluent system (Table 5) and columns designed for a carbonate/ bicarbonate eluent system (Table 6). All precision and accuracy data were collected for samples preserved with $\text{NH}_4\text{OH}/(\text{NH}_4)_2\text{SO}_4$. Figures 1 through 4 are chromatograms of Cr(VI) in reagent water and drinking water obtained under the conditions employed during method development.
- 13.2 SECOND LABORATORY EVALUATION – Four independent laboratories demonstrated acceptable method performance using 2- and 4-mm column systems with ammonium hydroxide/ammonium sulfate eluent, and one independent laboratory demonstrated acceptable method performance using a 4-mm column system with carbonate/bicarbonate eluent. The authors wish to acknowledge the Utah Water Research Laboratory (Logan, UT), Aqua Pennsylvania, Inc. (Bryn Mawr, PA), Metrohm USA, Inc. (Riverview, FL), Thermo Fisher Scientific/Dionex (Sunnyvale, CA), and MWH Laboratories (Monrovia, CA) for their contribution to the method development effort.
- 13.3 STORAGE STABILITY STUDY - Chlorinated surface water samples were preserved as required in Section 8 and stored over a 21-day period. Experimental conditions included samples fortified at 1.0 $\mu\text{g/L}$ Cr(VI), samples fortified with 1.0 $\mu\text{g/L}$ Cr(III), and unfortified samples (~ 0.060 $\mu\text{g/L}$ Cr(VI)). Unfortified samples (to study the storage stability of low-level Cr(VI) concentrations) were held under refrigerated and ambient storage temperatures. Both preservative systems were studied for each of the preceding conditions. Samples fortified with Cr(III), and samples fortified with Cr(III) plus an additional 3-mg/L chlorine were studied to confirm the ability of the method preservative to prevent oxidation of dissolved Cr(III). The percent recovery (based on the mean concentration at day zero) and precision of two replicate analyses for each condition conducted after 0, 1, 2, 7, 14, and 21

days of storage are presented in Section 17, Table 7. For samples fortified with Cr(III), results are expressed as the percent conversion of Cr(III) to Cr(VI) using the mean concentration of Cr(VI) at day zero as the baseline.

14. POLLUTION PREVENTION

- 14.1 For information about pollution prevention applicable to laboratory operations described in this method, consult: *Less is Better, Guide to Minimizing Waste in Laboratories*, a web-based resource available from the American Chemical Society at <http://www.acs.org>.

15. WASTE MANAGEMENT

- 15.1 The Agency requires that laboratory waste management practices be consistent with all applicable rules and regulations, and that laboratories protect the air, water, and land by minimizing and controlling all releases from fume hoods and bench operations. In addition, compliance is required with any sewage discharge permits and regulations, particularly the hazardous waste identification rules and land disposal restrictions.

16. REFERENCES

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17. REFERENCES, TABLES, DIAGRAMS, FLOWCHARTS, AND VALIDATION DATA

TABLE 1. ION CHROMATOGRAPHIC CONDITIONS USED TO COLLECT METHOD PERFORMANCE DATA: AMMONIUM HYDROXIDE/AMMONIUM SULFATE ELUENT

Parameter	Conditions		
Ion chromatograph	Dionex ICS 5000 with AS Autosampler and PC10 Post-column Pneumatic Delivery Package		
Guard Column	Dionex NG1 (4 x 35 mm)		
Anion Separator Column	Dionex IonPac® AS7 (4 x 250 mm)		
Column compartment temperature	30 °C	Autosampler tray temperature	Ambient
Eluent	Isocratic: 250 mM ammonium sulfate, 100 mM ammonium hydroxide		
Eluent flow rate	1.0 mL/min		
Post-column flow rate	0.33 mL/min		
Sample volume	1000µL		
Post-column reagent	2 mM 1,5-diphenylcarbazide, 10% methanol, 1 N sulfuric acid		
Reaction coil, temperature	750-µL knitted polytetrafluoroethylene reaction coil, 30 °C		
Detector, wavelength	UV-Vis absorbance, 530 nm		

TABLE 2. ION CHROMATOGRAPHIC CONDITIONS USED TO COLLECT METHOD PERFORMANCE DATA: CARBONATE/BICARBONATE ELUENT

Parameter	Conditions		
Ion chromatograph	Metrohm IC Professional 850, Model 887 UV-Vis Detector, Model 858 Autosampler, Model 800 Dosino post-column reagent delivery system		
Guard Column	Metrohm RP2 Guard/3.5		
Anion Separator Column	Metrohm Metrosep A SUPP 5-150/4		
Column compartment temperature	45 °C	Autosampler tray temperature	Ambient
Eluent	Isocratic: 12.8 mM sodium carbonate, 4.0 mM sodium bicarbonate		
Eluent flow rate	0.70 mL/min		
Post-column flow rate	0.22 mL/min		
Sample volume	1250µL		
Post-column reagent	2 mM 1,5-diphenylcarbazide, 10% methanol, 1 N sulfuric acid		
Reaction coil, temperature	375-µL knitted polytetrafluoroethylene reaction coil, ambient		
Detector, wavelength	UV-Vis absorbance, 530 nm		

TABLE 3. LOWEST CONCENTRATION MINIMUM REPORTING LEVELS (LCMRL) and DETECTION LIMITS (DL) for Cr(VI)

Conditions	Preservative	Calculated LCMRL, µg/L	DL Fortification Level, µg/L	DL
Ammonium hydroxide/ammonium sulfate eluent system	Liquid ^a	0.012	0.0125	0.0054
	Solid ^b	0.012	0.0125	0.0044
Carbonate/bicarbonate eluent system	Liquid ^a	0.036	0.050	0.010
	Solid ^b	0.023	0.020	0.015

^a NH₄OH/(NH₄)₂SO₄ (liquid) preservative.

^b CO₃²⁻/HCO₃⁻/(NH₄)₂SO₄ (solid) preservative.

TABLE 4. SINGLE LABORATORY PRECISION AND ACCURACY RESULTS FOR Cr(VI) IN REAGENT WATER (n=7); NH₄OH/(NH₄)₂SO₄ (LIQUID) PRESERVATIVE

	Mean % Recovery	% Relative Standard Deviation	Mean % Recovery	% Relative Standard Deviation	Mean % Recovery	% Relative Standard Deviation
Fortification:	0.020 µg/L		0.20 µg/L		1.0 µg/L	
Ammonium hydroxide/ammonium sulfate eluent system	90.9	4.2	93.5	1.5	94.4	1.8
Fortification:	0.0625 µg/L		0.20 µg/L		1.0 µg/L	
Carbonate/bicarbonate eluent system	98.5	8.0	96.9	4.9	96.2	0.93

TABLE 5. SINGLE LABORATORY PRECISION AND ACCURACY RESULTS FOR Cr(VI) IN DRINKING WATER MATRIXES USING AMMONIUM SULFATE/AMMONIUM HYDROXIDE ELUENT SYSTEM AND NH₄OH/(NH₄)₂SO₄ (LIQUID) PRESERVATIVE (n=7 unless noted)

	Native matrix µg/L	Mean % Recovery ^e	% Relative Standard Deviation	Mean % Recovery ^e	% Relative Standard Deviation
Fortification:	-	0.060 µg/L		1.0 µg/L	
Well water treated only by chlorination ^a	None detected	87.1	3.5	96.6	0.82
Fortification:	-	0.050 µg/L		1.0 µg/L	
Finished groundwater ^b	0.023	96.2	1.3	100	1.0
Finished surface water ^c	0.060 (n=3)	95.5	2.9	99.8	1.2
Finished surface water with GAC filtration ^d	0.048 (n=3)	94.4	2.4	98.3	0.75

^a Well water parameters: pH = 7.94; total hardness = 252 mg/L as CaCO₃; free chlorine = 0.03 mg/L; total chlorine = 0.64 mg/L.

^b Ground water parameters: pH = 7.66; total hardness = 322 mg/L as CaCO₃; free chlorine = 0.84 mg/L; total chlorine = 0.84 mg/L.

^c Surface water parameters: TOC = 3.1 mg/L C; pH = 6.77; total hardness = 120 mg/L as CaCO₃; free chlorine = 1.2 mg/L; total chlorine = 1.52 mg/L.

^d Surface water parameters: total hardness = 96 mg/L as CaCO₃; free chlorine = 1.12 mg/L; total chlorine = 1.22 mg/L. GAC = granular activated carbon.

^e Recoveries corrected for native levels in the unfortified matrix.

TABLE 6. SINGLE LABORATORY PRECISION AND ACCURACY RESULTS FOR Cr(VI) IN DRINKING WATER MATRIXES USING CARBONATE/BICARBONATE ELUENT SYSTEM AND NH₄OH/(NH₄)₂SO₄ (LIQUID) PRESERVATIVE (n=7 unless noted)

	Native matrix, µg/L	Mean % Recovery ^e	% Relative Standard Deviation	Mean % Recovery ^e	% Relative Standard Deviation
Fortification:	-	0.060 µg/L		1.0 µg/L	
Well water treated only by chlorination ^a	None detected	103	16	93.5	0.46
Fortification:	-	0.050 µg/L		1.0 µg/L	
Finished groundwater ^b	0.031	76.3	35	97.5	1.2
Finished surface water ^c	0.053 (n=3)	92.7	9.4	97.5	1.1
Finished surface water with GAC filtration ^d	0.033	98.6	4.4	96.1	1.6

^a Well water parameters: pH = 7.94; total hardness = 252 mg/L as CaCO₃; free chlorine = 0.03 mg/L; total chlorine = 0.64 mg/L.

^b Ground water parameters: pH = 7.66; total hardness = 322 mg/L as CaCO₃; free chlorine = 0.84 mg/L; total chlorine = 0.84 mg/L.

^c Surface water parameters: TOC = 3.1 mg/L C; pH = 6.77; total hardness = 120 mg/L as CaCO₃; free chlorine = 1.2 mg/L; total chlorine = 1.52 mg/L.

^d Surface water parameters: total hardness = 96 mg/L as CaCO₃; free chlorine = 1.12 mg/L; total chlorine = 1.22 mg/L. GAC = granular activated carbon.

^e Recoveries corrected for native levels in the unfortified matrix.

TABLE 7. SAMPLE HOLDING TIME DATA FOR Cr(VI) IN CHLORINATED SURFACE WATER^a PRESERVED AND STORED ACCORDING TO METHOD SECTION 8 (n = 2 for each experimental condition)

Experimental Condition	Fortification, $\mu\text{g/L}$	Day 0		Day 1		Day 2		Day 7		Day 14		Day 21	
		Mean Cr(VI) $\mu\text{g/L}$	RPD	Result, %	RPD	Result, %	RPD	Result, %	RPD	Result, %	RPD	Result, %	RPD
$\text{NH}_4\text{OH}/(\text{NH}_4)_2\text{SO}_4$ (liquid) preservative, 6 °C ^b	Native	0.059	1.5	103	1.2	98.5	2.6	106	2.9	110	5.3	113	4.7
$\text{CO}_3^{2-}/\text{HCO}_3^-/(\text{NH}_4)_2\text{SO}_4$ (solid) preservative, 6 °C ^b	Native	0.055	6.5	97.8	0.0	99.8	3.3	99.2	0.18	101	3.4	101	1.3
$\text{NH}_4\text{OH}/(\text{NH}_4)_2\text{SO}_4$ (liquid) preservative, 6 °C ^b	1.0 Cr(VI)	1.04	0.33	100	1.8	100	0.46	104	1.4	102	0.12	102	1.1
$\text{CO}_3^{2-}/\text{HCO}_3^-/(\text{NH}_4)_2\text{SO}_4$ (solid) preservative, 6 °C ^b	1.0 Cr(VI)	1.03	1.2	100	1.0	100	0.70	103	1.5	100	2.1	102	0.24
$\text{NH}_4\text{OH}/(\text{NH}_4)_2\text{SO}_4$ (liquid) preservative, 6 °C ^c	1.0 Cr(III)	0.072	3.2	0.43	7.7	0.67	4.8	1.6	6.0	2.7	8.2	3.2	5.0
$\text{CO}_3^{2-}/\text{HCO}_3^-/(\text{NH}_4)_2\text{SO}_4$ (solid) preservative, 6 °C ^c	1.0 Cr(III)	0.068	0.74	0.45	5.1	0.24	2.1	0.60	5.1	0.73	6.6	0.93	10
$\text{NH}_4\text{OH}/(\text{NH}_4)_2\text{SO}_4$ (liquid) preservative, 6 °C (fortified w/additional 3 mg/L Cl_2) ^c	1.0 Cr(III)	0.077	4.7	-0.025	4.5	-0.16	8.6	2.4	7.5	3.4	4.2	4.7	0.88
$\text{CO}_3^{2-}/\text{HCO}_3^-/(\text{NH}_4)_2\text{SO}_4$ (solid) preservative, 6 °C (fortified w/additional 3 mg/L Cl_2) ^c	1.0 Cr(III)	0.064	7.8	-0.53	10	-0.76	2.3	0.17	15	-0.12	3.5	0.53	0.57
$\text{NH}_4\text{OH}/(\text{NH}_4)_2\text{SO}_4$ (liquid) preservative, ambient storage ^b	Native	0.060	1.7	100	8.7	100	6.7	110	3.4	117	15	118	2.0
$\text{CO}_3^{2-}/\text{HCO}_3^-/(\text{NH}_4)_2\text{SO}_4$ (solid) preservative, ambient storage ^b	Native	0.056	2.5	99.0	4.2	94.9	3.6	98.7	3.6	105	4.1	101	2.3

^a Surface water parameters: TOC = 3.1 mg/L C; pH = 6.77; total hardness = 120 mg/L as CaCO_3 ; free chlorine = 1.2 mg/L; total chlorine = 1.52 mg/L.

^b Result expressed as the percent recovery of Cr(VI) relative to the mean concentration at Day 0, e.g. at Day 1: (Mean [Cr(VI)] / Mean [Cr(VI)] Day 0) * 100.

^c Result expressed as the percent conversion of Cr(III) to Cr(VI) using the mean concentrations at Day 0 as the baseline, e.g. at Day 1: (Mean [Cr(VI)] - Mean [Cr(VI)] Day 0) / 1.0 $\mu\text{g/L}$ Cr(III) * 100.

TABLE 8. INITIAL DEMONSTRATION OF CAPABILITY (IDC) QUALITY CONTROL REQUIREMENTS

Method Reference	Requirement	Specification and Frequency	Acceptance Criteria
Section 9.2.1	Demonstration of low system background	Analyze an LRB after the high calibration standard during the IDC calibration.	Cr(VI) concentration is <1/3 of the MRL.
Section 9.2.2	Demonstration of precision	Analyze seven replicate Laboratory Fortified Blanks (LFBs) fortified near the midrange of the calibration curve.	Percent relative standard deviation must be $\leq 15\%$.
Section 9.2.3	Demonstration of accuracy	Calculate average recovery for replicates used in Section 9.2.2.	Mean recovery within $\pm 15\%$ of the true value.
Section 9.2.4	MRL confirmation	Fortify and analyze seven replicate LFBs at the chosen MRL concentration. Confirm that the Upper Prediction Interval of Results (PIR) and Lower PIR (Sect. 9.2.4.2) meet the recovery criteria.	Upper PIR $\leq 150\%$ Lower PIR $\geq 50\%$
Section 9.2.5	Quality Control Sample (QCS)	Analyze mid-level QCS.	Cr(VI) must be within $\pm 15\%$ of the true value.

TABLE 9. ONGOING QUALITY CONTROL REQUIREMENTS

Method Reference	Requirement	Specification and Frequency	Acceptance Criteria
Section 10.2	Initial calibration	Use the external standard calibration technique to generate a linear or quadratic calibration curve. Use at least six standard concentrations. Validate the calibration curve as described in Section 10.2.3.	When each calibration standard is calculated as an unknown using the regression equations, the lowest level standard should be within $\pm 50\%$ of the true value. All other points should be within $\pm 15\%$ of the true value.
Section 9.3.1	Laboratory Reagent Blank (LRB)	Analyze one LRB with each Analysis Batch.	Demonstrate that Cr(VI) is below $\frac{1}{3}$ the Minimum Reporting Level (MRL), and that other sources of interference do not prevent identification and quantitation.
Section 10.3	Continuing Calibration Check (CCC)	Verify initial calibration by analyzing a low-level CCC at the beginning of each Analysis Batch. Subsequent CCCs are required after every 10 field samples and after the last field sample in a batch.	The lowest level CCC must be within $\pm 50\%$ of the true value. All other points must be within $\pm 15\%$ of the true value. Results for field samples that are not bracketed by acceptable CCCs are invalid.
Section 9.3.4	Laboratory Fortified Sample Matrix (LFSM)	Analyze one LFSM per Analysis Batch. Fortify the LFSM with Cr(VI) at a concentration greater than the native concentrations. Calculate LFSM recovery.	For LFSMs fortified at concentrations $\leq 2 \times$ MRL, the result must be within $\pm 50\%$ of the true value. At concentrations greater than the $2 \times$ MRL, the result must be within $\pm 15\%$ of the true value.
Section 9.3.5	Laboratory Fortified Sample Matrix Duplicate (LFSMD) or Laboratory Duplicate (LD)	Analyze at least one LFSMD or LD with each Analysis Batch.	For LFSMDs or LDs, relative percent differences must be $\leq 15\%$. ($\leq 50\%$ if concentration $\leq 2 \times$ MRL.)
Section 9.3.6	Quality Control Sample (QCS)	Analyze mid-level QCS with each new calibration curve.	Cr(VI) must be $\pm 15\%$ of the true value.

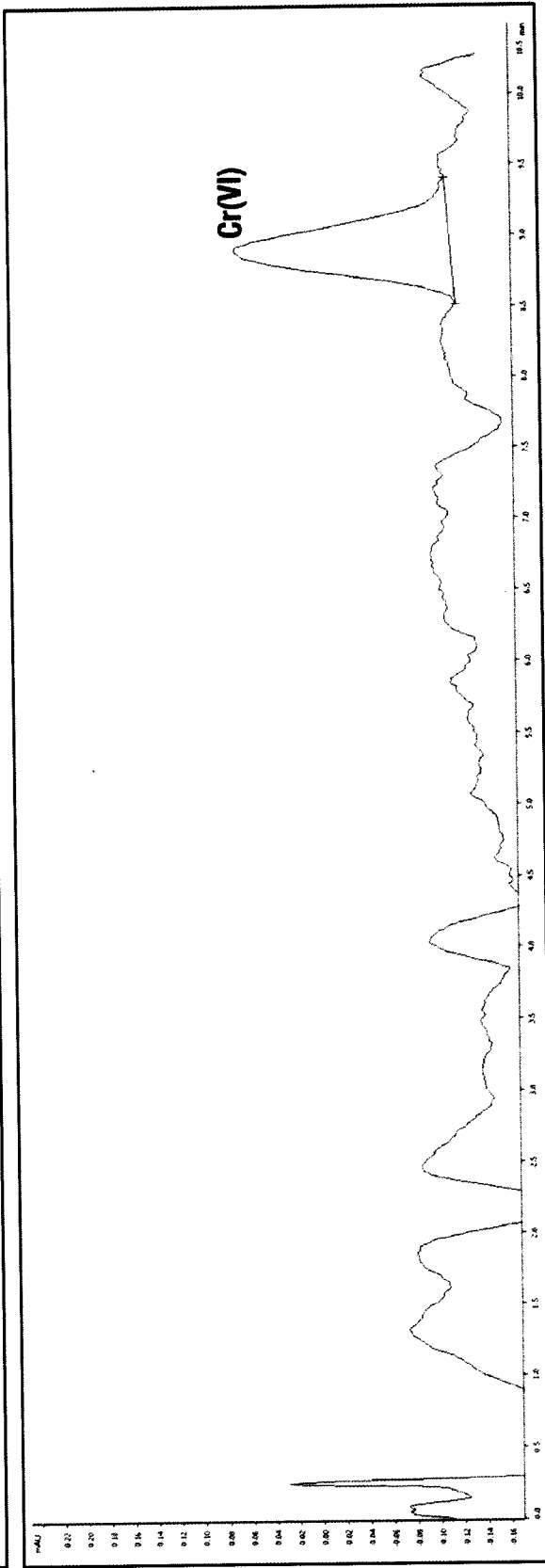
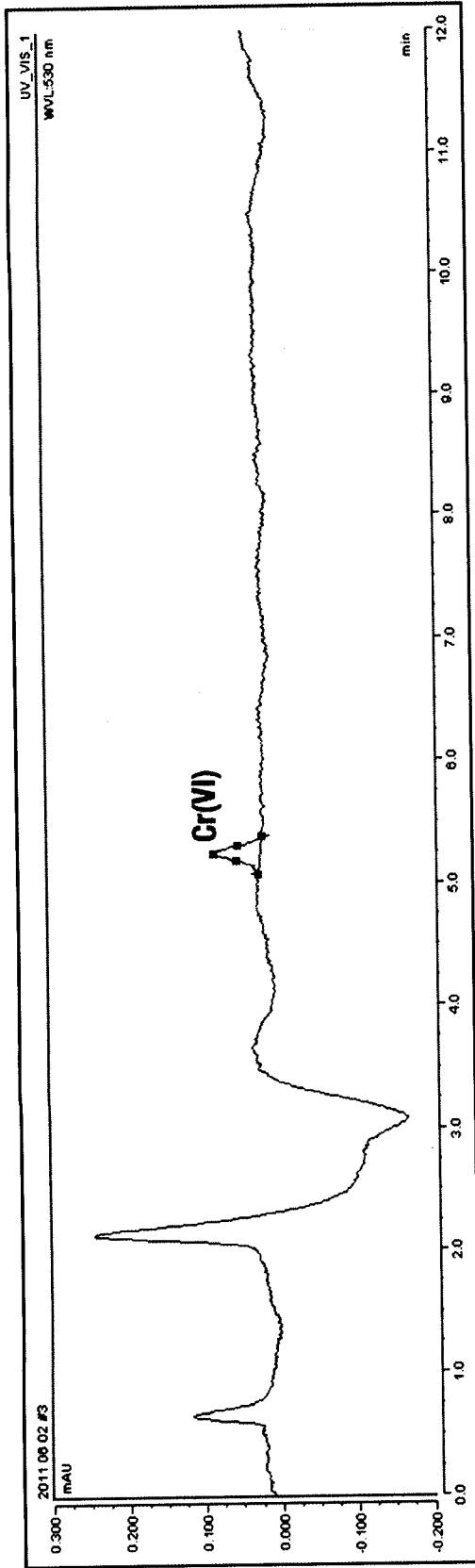


Figure 1. Calibration standards, $\text{NH}_4\text{OH}/(\text{NH}_4)_2\text{SO}_4$ (liquid) preservative: 0.020 $\mu\text{g}/\text{L}$ analyzed using ammonium hydroxide/monium sulfate eluent system (top) and 0.050 $\mu\text{g}/\text{L}$ analyzed using carbonate/bicarbonate eluent system (bottom).

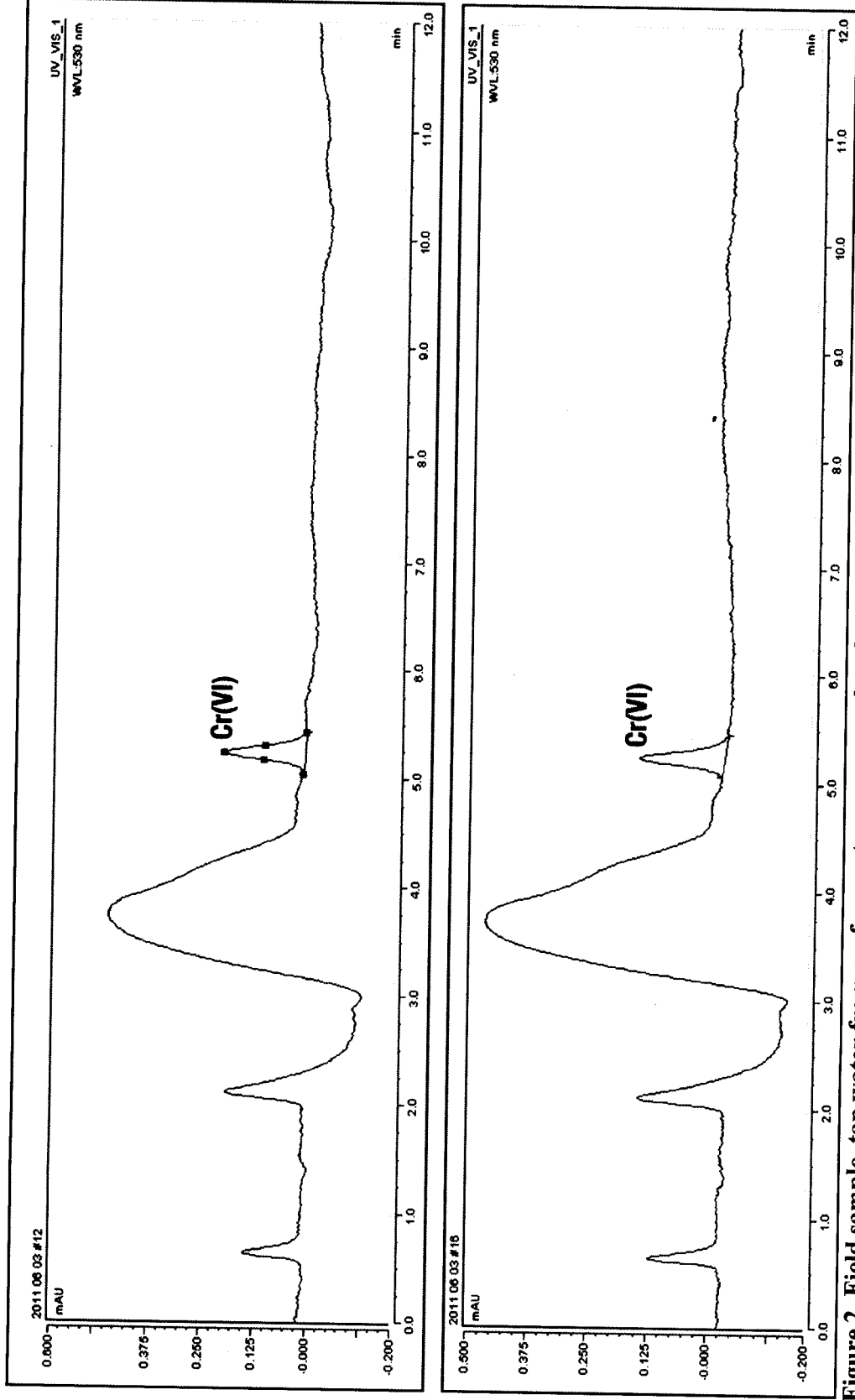


Figure 2. Field sample, tap water from surface water source analyzed using ammonium hydroxide/ammonium sulfate eluent system: $\text{NH}_4\text{OH}/(\text{NH}_4)_2\text{SO}_4$ (liquid) preservative (top) and $\text{CO}_3^{2-}/\text{HCO}_3^-/(\text{NH}_4)_2\text{SO}_4$ (solid) preservative (bottom); native concentration is $\sim 0.060 \mu\text{g/L}$.

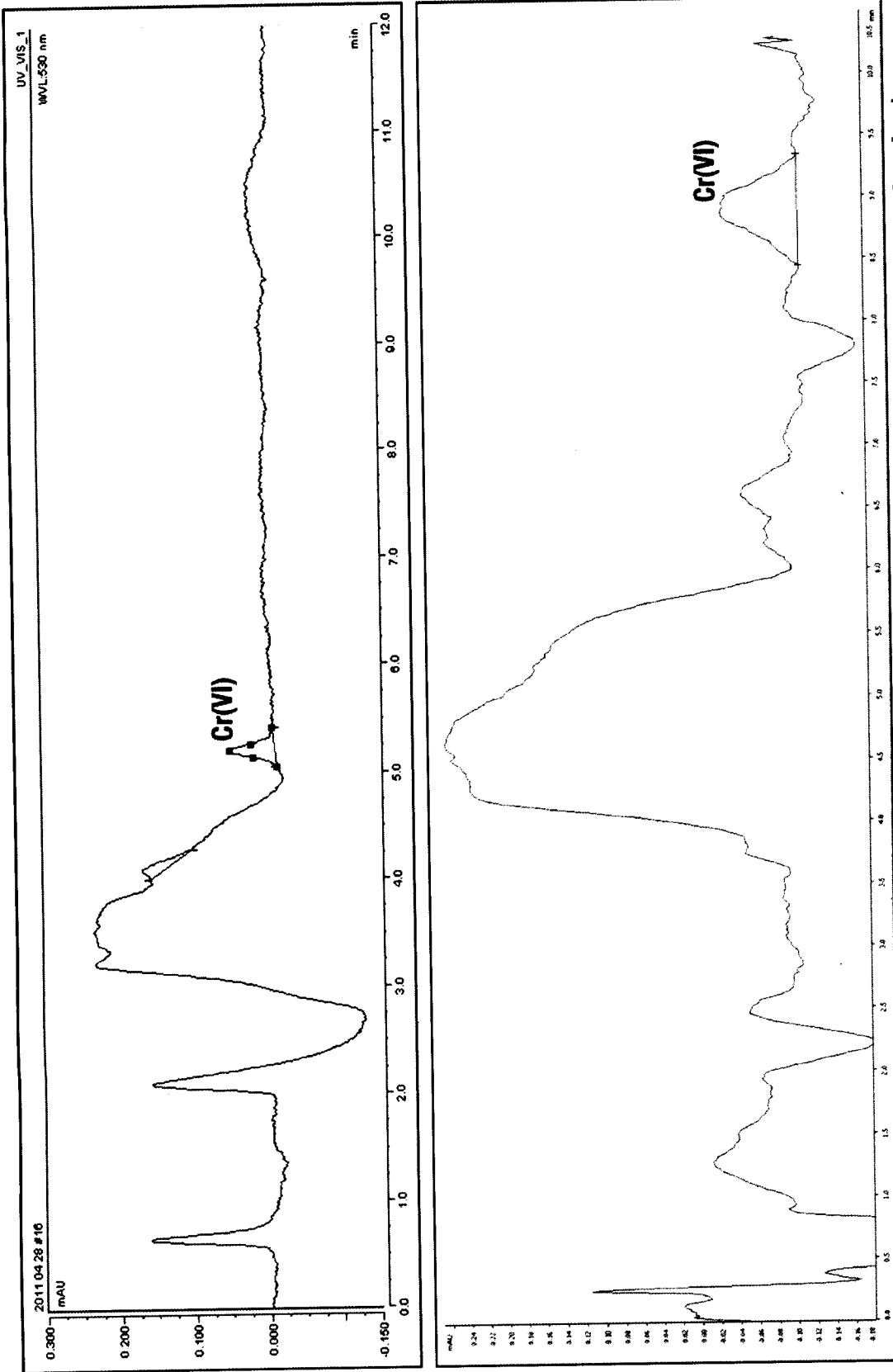


Figure 3. Field sample, tap water from a ground water source, $\text{NH}_4\text{OH}/(\text{NH}_4)_2\text{SO}_4$ (liquid) preservative: analyzed using ammonium hydroxide/ammonium sulfate eluent system (top) and using carbonate/bicarbonate eluent system (bottom); native concentration is $\sim 0.020 \mu\text{g/L}$.

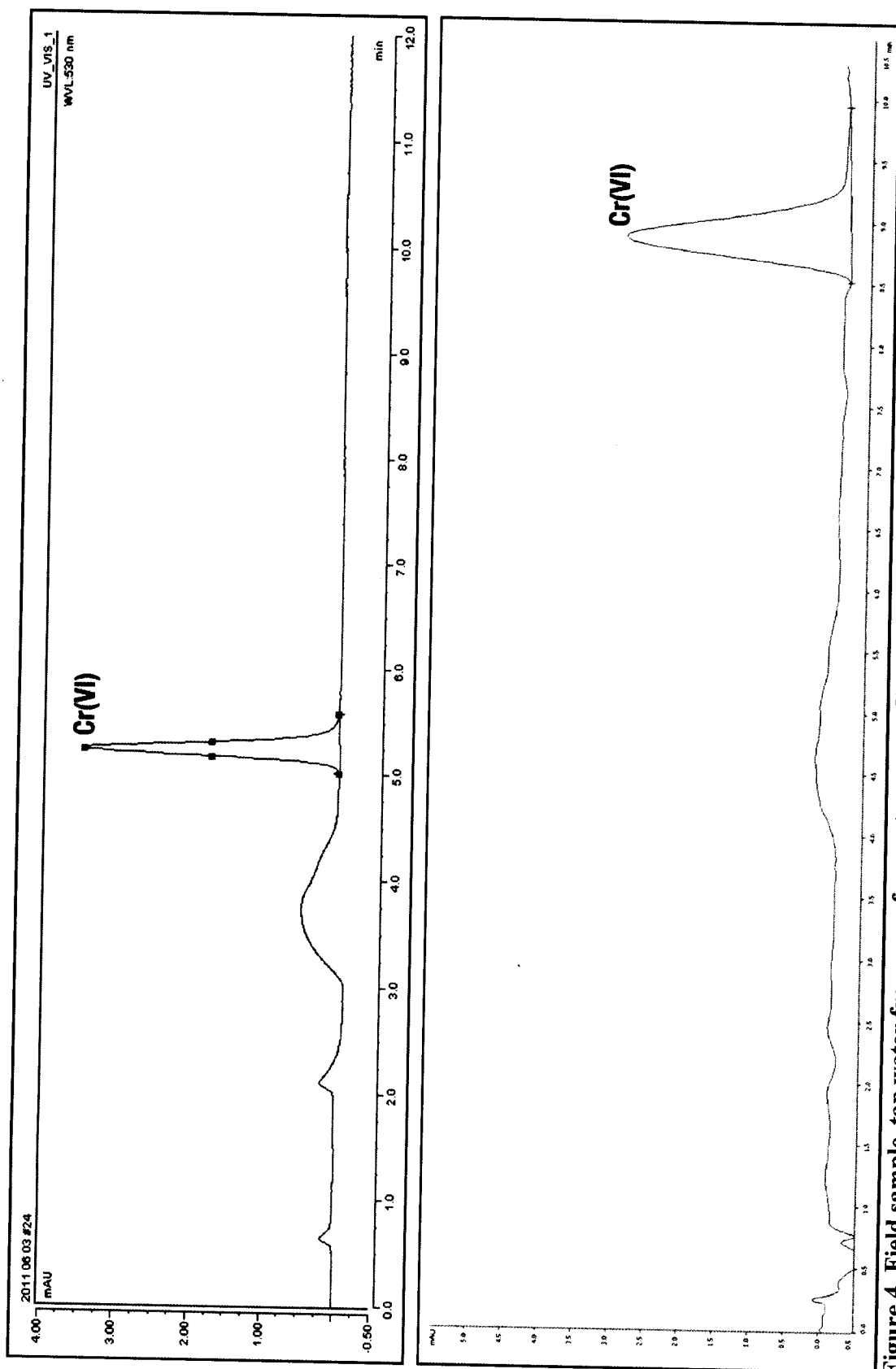


Figure 4. Field sample, tap water from a surface water source, $\text{NH}_4\text{OH}/(\text{NH}_4)_2\text{SO}_4$ (liquid) preservative: analyzed using ammonium hydroxide/ammonium sulfate eluent system (top) and using carbonate/bicarbonate eluent system (bottom); LFSM at 1.0 $\mu\text{g/L}$.

METHOD #: 218.6 Recommended for Approval for NPDES (August, 1991)

TITLE: Determination Of Dissolved Hexavalent Chromium In Drinking Water, Groundwater And Industrial Wastewater Effluents By Ion Chromatography

ANALYTE: CAS # Chromium 7440-47-3, Cr

INSTRUMENTATION: IC

1.0 Scope and Application

- 1.1 This method provides procedures for the determination of dissolved hexavalent chromium in drinking water, groundwater and industrial wastewater effluents.
- 1.2 The Method Detection Limits (MDL, defined in Section 3) for the above matrices are listed in Table 1. The MDL obtained by an individual laboratory for a specific matrix may differ from those listed depending on the nature of the sample and the instrumentation used.
- 1.3 Samples containing high levels of anionic species such as sulfate and chloride may cause column overload. Samples containing high levels of organics or sulfides cause rapid reduction of soluble Cr(VI) to Cr(III). Samples must be stored at 4°C and analyzed within twenty-four hours of collection.
- 1.4 This method should be used by analysts experienced in the use of ion chromatography and the interpretation of ion chromatograms.

2.0 Summary of Method

- 2.1 An aqueous sample is filtered through a 0.45 µm filter and the filtrate is adjusted to a pH of 9 to 9.5 with a buffer solution. A measured volume of the sample (50-250 µL) is introduced into the ion chromatograph. A guard column removes organics from the sample before the Cr(VI) as CrO_4^{2-} is separated on an anion exchange separator column. Post-Column derivatization of the Cr(VI) with diphenylcarbazide is followed by detection of the colored complex at 530 nm.

3.0 Definitions

- 3.1 Dissolved--Material that will pass through a 0.45 µm membrane filter.
- 3.2 Method Detection Limit (MDL)- The minimum concentration of an analyte that can be identified, measured and reported with 99% confidence that the analyte concentration is greater than zero and determined from analysis of a sample in a given matrix containing analyte (1).
- 3.3 Linear Dynamic Range- The concentration range over which the analytical working curve remains linear.
- 3.4 Laboratory Reagent Blank (LRB)- An aliquot of reagent water that is treated exactly like a sample including exposure to all glassware, equipment, solvents and reagents that are used with samples. The LRB is used to determine if the method analyte is present in the laboratory environment, the reagents or apparatus.

- 3.5 Stock Standard Solution- A concentrated, certified standard solution of the method analyte. The stock standard solution is used to prepare calibration standards.
- 3.6 Calibration Standard (CAL)- A solution prepared from the stock standard and used to calibrate the instrument response with respect to analyte concentration.
- 3.7 Laboratory Fortified Blank (LFB)- An aliquot of reagent water to which a known quantity of method analyte is added in the laboratory. The LFB is analyzed exactly like a sample, and its purpose is to determine whether the method is within accepted control limits.
- 3.8 Laboratory Fortified Sample Matrix (LFM)- An aliquot of an environmental sample to which a known quantity of method analyte is added in the laboratory. The LFM is analyzed exactly like a sample, and its purpose is to determine whether the sample matrix contributes bias to the analytical result. The background concentration of the analyte in the sample matrix must be determined in a separate aliquot and the measured value in the LFM corrected for the concentration found.
- 3.9 Quality Control Sample (QCS)- A solution containing a known concentration of analyte prepared by a laboratory other than the laboratory performing the analysis. The sample is used to check laboratory performance.
- 3.10 Laboratory Duplicates (LD)- Two aliquots of the same sample that are treated exactly the same throughout preparative and analytical procedures. Analyses of laboratory duplicates indicate precision associated with laboratory procedures.
- 3.11 Laboratory Performance Check Standards (LPC)- A solution of the analyte prepared in the laboratory by making appropriate dilutions of the stock standard in reagent water. The LPC is used to evaluate the performance of the instrument system within a given calibration Curve.

4.0 Interferences

- 4.1 Interferences which affect the accurate determination of Cr(VI) may come from several sources.
 - 4.1.1 Contamination- A trace amount of Cr is sometimes found in reagent grade salts. Since a concentrated buffer solution is used in this method to adjust the pH of samples, reagent blanks should be analyzed to assess for potential Cr(VI) contamination. Contamination can also come from improperly cleaned glassware or contact of caustic or acidic reagents or samples with stainless steel or pigmented material.
 - 4.1.2 Oxidation of soluble Cr(III) to Cr(VI) can occur in an alkaline medium in the presence of oxidants such as Fe(III) and oxidized Mn or as a result of the aeration that occurs in most extraction procedures (2-5).
 - 4.1.3 Reduction of Cr(VI) to Cr(III) can occur in the presence of reducing species in an acidic medium. At a pH of 6.5 or greater, however, HCrO_4^{-1} is converted to CrO_4^{2-} which is less reactive than the HCrO_4^{-1} .
 - 4.1.4 Overloading of the analytical column capacity with high concentrations of anionic species, especially chloride and sulfate, will cause a loss of Cr(VI). The column specified in this method can handle samples containing up to 5% sodium sulfate or 2% sodium chloride (6). Poor recoveries from fortified samples and tailing peaks are typical manifestations of column overload.

5.0 Safety

- 5.1 Hexavalent chromium is toxic and a suspected carcinogen and should be handled with appropriate precautions (3,4). Extreme care should be exercised when weighing the salt for preparation of the stock standard. Each laboratory is responsible for maintaining a current awareness file of OSHA regulations regarding the safe handling of chemicals specified in this method. A reference file of material safety data sheets should also be available to all personnel involved in the chemical analysis (7,8).

6.0 Apparatus and Equipment

6.1 Ion Chromatograph

- 6.1.1 Instrument equipped with a pump capable of withstanding a minimum backpressure of 2000 psi and capable of delivering a constant flow in the range of 1-5 mL/min and containing no metal parts in the sample, eluent or reagent flow path.
- 6.1.2 Helium gas supply (high purity, 99.995%).
- 6.1.3 Pressurized eluent container, plastic, one or two liter size.
- 6.1.4 Sample loops of various sizes (50-250 μ L).
- 6.1.5 A pressurized reagent delivery module with a mixing tee and beaded mixing coil.
- 6.1.6 Guard Column- A column placed before the separator column containing a sorbent capable of removing strongly absorbing organics and particles that would otherwise damage the separator column (Dionex IonPac NG1 or equivalent).
- 6.1.7 Separator Column- A column packed with a high capacity anion exchange resin capable of resolving CrO_4^{2-} from other sample constituents (Dionex IonPac AS7 or equivalent).
- 6.1.8 A low-volume flow-through cell visible lamp detector containing no metal parts in contact with the eluent flow path. Detection wavelength is at 530 nm.
- 6.1.9 Recorder, integrator or computer for receiving analog or digital signals for recording detector response (peak height or area) as a function of time.

- 6.2 Labware- All reusable glassware (glass, quartz, polyethylene, Teflon, etc.) including the sample containers should be soaked overnight in laboratory grade detergent and water, rinsed with water, and soaked for four hours in a mixture of dilute nitric and hydrochloric acid (1+2+9) followed by rinsing with tap water and ASTM Type I water.

NOTE: chromic acid must not be used for the cleaning of glassware.

- 6.2.1 Glassware- Class A volumetric flasks and a graduated cylinder.
- 6.2.2 Assorted Class A calibrated pipettes.
- 6.2.3 10 mL male luer-lock disposable syringes.
- 6.2.4 0.45 μ m syringe filters.
- 6.2.5 Storage bottle-high density polypropylene, 1 liter capacity.
- 6.3 Sample Processing Equipment
- 6.3.1 Liquid sample transport containers- high density polypropylene, 125 mL capacity.

- 6.3.2 Supply of dry ice or refrigerant packing and styrofoam shipment boxes.
- 6.3.3 pH meter- to read pH range 0-14 with accuracy ± 0.03 pH.
- 6.3.4 0.45 μm filter discs, 7.3 cm diameter (Gelman Acro 50A, Mfr. No.4262 or equivalent)
- 6.3.5 Plastic syringe filtration unit (Baxter Scientific, Cat. No. 1240 IN or equivalent).

7.0 Reagents and Consumable Materials

- 7.1 Reagents- All chemicals are ACS grade unless otherwise indicated.
 - 7.1.1 Ammonium hydroxide, NH_4OH , (sp.gr. 0.902), (CAS RN 1336-21-6).
 - 7.1.2 Ammonium sulfate, NH_4SO_4 , (CAS RN 7783-20-2).
 - 7.1.3 1,5 Diphenylcarbazide, (CAS RN 1 40-22-7).
 - 7.1.4 Methanol, HPLC grade.
 - 7.1.5 Sulfuric acid, concentrated (sp.gr. 1.84).
- 7.2 Water- For all sample preparations and dilutions, ASTM Type I water (ASTM D1193) is required. Suitable water may be obtained by passing distilled water through a mixed bed of anion and cation exchange resins.
- 7.3 Cr(VI) Stock Solution- Dissolve 4.501 g of $\text{Na}_2\text{CrO}_4 \cdot 4\text{H}_2\text{O}$ in ASTM Type I water and dilute to one liter. Transfer to a polypropylene storage container.
- 7.4 Laboratory Reagent Blank (LRB)- Aqueous LRBs can be prepared by adjusting the pH of ASTM Type I water to 9-9.5 with the same volume of buffer as was used for the samples.
- 7.5 Laboratory Fortified Blank (LFB)- To an aliquot of reagent blank add an aliquot of stock standard to produce a final concentration of 100 $\mu\text{g/L}$ of Cr(VI). The LFB must be carried through the entire sample preparation and analysis scheme.
- 7.6 Quality Control Sample (QCS)- A quality control sample must be obtained from an outside laboratory. Dilute an aliquot according to instructions and analyze with samples.
- 7.7 Eluent- Dissolve 33 g of ammonium sulfate in 500 mL of ASTM Type I water and add 6.5 mL of ammonium hydroxide. Dilute to one liter with ASTM Type I water.
- 7.8 Post-column Reagent- Dissolve 0.5 g of 1,5 diphenylcarbazide in 100 mL of HPLC grade methanol. Add to about 500 mL of ASTM Type I water containing 28 mL of 98% sulfuric acid while stirring. Dilute with ASTM Type I water to one liter in a volumetric flask. Reagent is stable for four or five days but should only be prepared in one liter quantities as needed.
- 7.9 Buffer Solution- Dissolve 33 g of ammonium sulfate in 75 mL of ASTM Type I water and add 6.5 mL of ammonium hydroxide. Dilute to 100 mL with ASTM Type I water.

8.0 Sample Collection, Preservation and Storage

- 8.1 Prior to the collection of the sample, consideration should be given to the type of data required so that appropriate preservation and pretreatment steps can be taken. Filtration and pH adjustment should be performed at the time of sample collection or as soon thereafter as practically possible.

- 8.2 For the determination of dissolved Cr(VI), the sample should be filtered through a 0.45 μ m filter. Use a portion of the sample to rinse the syringe filtration unit and filter and then collect the required volume of filtrate. Adjust the pH of the sample to 9-9.5 by adding dropwise a solution of the buffer, periodically checking the pH with the pH meter. Approximately 10 mLs of sample are sufficient for three IC analyses.
- 8.3 Ship and store the samples at 4°C. Bring to ambient temperature prior to analysis. Samples should be analyzed within twenty-four hours of collection.

9.0 Calibration

- 9.1 Calibration- At the time samples are analyzed a calibration should be performed using a minimum of three calibration solutions that bracket the anticipated concentration range of the samples. Calibration standards should be prepared from the stock standard (Section 7.3) by appropriate dilution with ASTM Type I water (Section 7.2) in volumetric flasks. The solution should be adjusted to a pH of 9-9.5 with the buffer solution (Section 7.9) prior to final dilution.
 - 9.1.1 Establish ion chromatographic operating conditions as indicated in Table 2. The flow rate of the eluent pump is set at 1.5 mL/min and the pressure of the reagent delivery module adjusted so that the final flow rate from the detector is 2.0 mL/min. This requires manual adjustment and measurement of the final flow using a graduated cylinder and a stop watch. A warm up period of approximately 30 minutes after the flow rate has been adjusted is recommended and the flow rate should be checked prior to calibration and sample analysis.
 - 9.1.2 Injection loop size is chosen based on standard and sample concentrations and the selected attenuator setting. A 250 μ L loop was used to establish the method detection limits in Table 1. A 50 μ L loop is normally sufficient for higher concentrations. The sample volume used to load the injection loop should be at least 10 times the loop size so that all tubing in contact with sample is thoroughly flushed with new sample to prevent cross contamination.
 - 9.1.3 A calibration curve of analyte response (peak height or area) versus analyte concentration should be constructed. The coefficient of correlation for the curve should be 0.999 or greater.
- 9.2 Instrument Performance- Check the performance of the instrument and verify the calibration using data gathered from analyses of laboratory blanks, calibration standards and the quality control sample.
 - 9.2.1 After the calibration has been established, it should be verified by analyzing the QCS (Section 7.6). If the measured value of the QCS exceeds $\pm 10\%$ of the established value, a second analysis should be performed. If the value still exceeds the established value, the analysis should be terminated until the source of the problem is identified and corrected.
 - 9.2.2 To verify that the instrument is properly calibrated on a continuing basis, run an LRB and an LPC after every ten analyses. The results of the analyses of the standards will indicate whether the calibration remains valid. If the measured concentration of the analyte deviates from the true concentration by more than $\pm 5\%$, the instrument must be

recalibrated and the previous ten samples re-analyzed. The instrument response from the calibration check may be used for recalibration purposes.

10.0 Quality Control

10.1 Each laboratory using this method is required to operate a formal Quality Control (QC) program. The minimum requirements of this program consist of an initial demonstration of laboratory capability, and the analysis of laboratory reagent blanks, fortified blanks and samples as a continuing check on performance. The laboratory is required to maintain performance records that define the quality of the data thus generated.

10.2 Initial Demonstration of Performance

10.2.1 The initial demonstration of performance is used to characterize instrument performance (method detection limits and linear calibration ranges) for analyses conducted by this method.

10.2.2 Method Detection Limit (MDL)- Method Detection Limit should be established using reagent water (blank) fortified at a concentration of two to five times the estimated detection limit. To determine the MDL value, take seven replicate aliquots of the fortified reagent water and process through the entire analytical method. Perform all calculations defined in the method and report the concentration values in the appropriate units. Calculate the MDL as follows:

$$MDL = (t) \times (s)$$

where:

t = students' t value for a 99% confidence level and a standard deviation estimate with n-1 degrees of freedom [t = 3.143 for seven replicates].

s = standard deviation of the replicate analyses.

10.2.3 Linear dynamic range- linear dynamic ranges are governed by Beer's Law. A set of at least five standards covering the estimated linear range should be prepared fresh from the stock solution and one analysis of each performed. A log vs. log plot of peak height vs. analyte concentration having a slope between 0.98 and 1.02 will indicate linearity (7). The linear dynamic range for this method covered four orders of magnitude (1 µg/L to 10,000 µg/L) when peak height was used.

10.3 Assessing Laboratory Performance Reagent and Fortified Blanks

10.3.1 Laboratory Reagent Blank (LRB)- the laboratory must analyze at least one reagent blank (Section 7.4) with each set of samples. Reagent blank data are used to assess contamination from a laboratory environment. If the Cr(VI) value in the reagent blank exceeds the determined MDL, then laboratory or reagent contamination should be suspected. Any determined source of contamination should be corrected and the samples re-analyzed.

- 10.3.2 Laboratory Fortified Blank (LFB)- the laboratory must analyze at least one fortified blank (Section 7.5) with each set of samples. Calculate accuracy as percent recovery (see 10.4.2). If the recovery of Cr(VI) falls outside the control limits (see 10.3.3), then the procedure is judged out of control, and the source of the problem should be identified and resolved before continuing the analysis.
- 10.3.3 Until sufficient data become available (usually a minimum of twenty to thirty analyses), the laboratory should assess laboratory performance against recovery limits of 90-110%. When sufficient internal performance data becomes available, develop control limits from the percent mean recovery (\bar{x}) and the standard deviation (s) of the mean recovery. These data are used to establish upper and lower control limits as follows:
 Upper Control Limit = $\bar{x} + 3s$
 Lower Control Limit = $\bar{x} - 3s$

10.4 Assessing Analyte Recovery- Laboratory Fortified Sample Matrix

- 10.4.1 The laboratory must add a known amount of Cr(VI) to a minimum of 10% of the routine samples. The concentration level can be the same as that of the laboratory fortified blank (Section 7.5) for liquid samples.
- 10.4.2 Calculate the percent recovery for Cr(VI) corrected for background concentration measured in the unfortified sample, and compare this value to the control limits established in Section 10.3.3 for the analysis of LFBs. Fortified recovery calculations are not required if the fortified concentration is less than 10% of the sample background concentration. Percent recovery may be calculated in units appropriate to the matrix, using the following equation:

$$R = \frac{(C_F - C) \times 100}{F}$$

Where:

- R = percent recovery.
 C_F = fortified sample concentration.
 C = sample background concentration.
 F = concentration equivalent of Cr(VI) added to sample.

- 10.4.3 If the recovery of Cr(VI) falls outside control limits, while the recovery obtained for the LFB was shown to be in control (Section 10.3), the recovery problem encountered with the fortified sample is judged to be matrix related, not system related. The result for Cr(VI) in the unfortified sample must be labelled "suspect matrix".
- 10.5 Quality Control Sample (QCS)- Each quarter, the laboratory should analyze one or more QCS (if available). If criteria provided with the QCS are not met, corrective action should be taken and documented.

11.0 Procedure

- 11.1 Sample Preparation Filtered, pH adjusted samples at 4°C should be brought to ambient temperature prior to analysis.
- 11.2 Initiate instrument operating configuration and calibrate (Section 9).
- 11.3 Draw into a new, unused syringe (6.2.3) approximately 3 mL of sample and attach a syringe filter to the syringe. Discard 0.5 mL through the filter and load 10X the sample loop volume. Samples having concentrations higher than the established linear dynamic range should be diluted into the calibration range and re-analyzed.

12.0 Calculations

- 12.1 From the calibration curve the concentration of the sample can be determined. For the above procedure, if there is no dilution, the concentration of the sample should be reported as µg/L. Data should be corrected for any Cr(VI) contamination found in reagent blanks.
- 12.2 The QC data obtained during the analyses provide an indication of the quality of the sample data and should be provided with the sample results.

13.0 Precision and Accuracy

- 13.1 Instrument operating conditions used for single laboratory testing of the method are summarized in Table 2. Dissolved Cr(VI) method detection limits determined using the procedure in 10.2.2 are listed in Table 1.
- 13.2 Data obtained from single laboratory testing of the method are summarized in Table 3 for five water samples representing drinking water, deionized water, groundwater, treated municipal sewage wastewater and treated electroplating wastewater. Samples were fortified with 100 and 1000 µg/L of Cr(VI) and recoveries determine (Section 10.4.2).

14.0 References

- 1. Glaser, J.A., Foerst, D.L., McKee, G.D., Quave, S.A. and Budde, W.L., "Trace Analyses for Wastewaters," Environmental Science and Technology, Vol. 15, No. 12, 1981, PP. 1426-1435.
- 2. Bartlett, R. and James, B., "Behavior of Chromium in Soils: III. Oxidation," J. Environ. Qual., Vol. 8, No. 1, 1979, pp. 31-35.
- 3. Zatka, V.J., "Speciation of Hexavalent Chromium in Welding Fumes Interference by Air Oxidation of Chromium," Am. Ind. Hyg. Assoc. J., Vol. 46, No. 7, 1985, pp. 327-331.
- 4. Pedersen, B., Thomsen, E. and Stern, R.M., "Some Problems in Sampling, Analysis and Evaluation of Welding Fumes Containing Cr(VI)", Ann. Occup. Hyg., Vol. 31, No. 3, 1987, pp. 325-338.
- 5. Messman, J.D., Churchwell, M.E., et. al. Determination of Stable Valence States of Chromium in Aqueous and Solid Waste Matrices - Experimental Verification of Chemical Behavior. EPA/600/S4-86/039, U.S. Environmental Protection Agency, Cincinnati, Ohio, 1987, 112 pp.
- 6. Dionex Technical Note No. 26, May 1990.

7. "Proposed OSHA Safety and Health Standards, Laboratories," Occupational Safety and Health Administration, Federal Register, July 24, 1986.
8. "OSHA Safety and Health Standards, General Industry," (29 CFR 1910), Occupational Safety and Health Administration, OSHA 2206, revised January 1976.
9. Johnson, D.C., Anal. Chim. Acta, Vol. 204, No. 1 1988.

Table 1. Method Detection Limit for Cr(VI)

Matrix Type	Conc. used to compute MDL (µg/L)	Method Detection Limit (a) (µg/L)
Reagent Water	1	0.4
Drinking Water	2	0.3
Ground Water	2	0.3
Primary Sewage Wastewater	2	0.3
Electroplating Wastewater	2	0.8

(a) MDL concentrations are computed for final analysis solution (Section 11.2).

Table 2. Ion Chromatographic Conditions

Columns:	Guard Column - Dionex IonPac NG1 Separator Column - Dionex IonPac AS7
Eluent:	250 mM (NH ₄) ₂ SO ₄ 100 mM NH ₄ OH Flow rate - 1.5 mL/min
Post-Column Reagent:	2 mM Diphenylcarbohydrazide 10% v/v CH ₃ OH 1 N H ₂ SO ₄ Flow rate - 0.5 mL/min
Detector:	Visible 530 nm
Retention Time:	3.8 min.

Table 3. Single- Laboratory Precision and Accuracy

Sample Type	Percent Mean Cr(VI) ^(a) (µg/L)	Recovery	RPD ^(b)
Reagent Water	100	100	0.8
	1000	100	0.0
Drinking Water	100	105	6.7
	1000	98	1.5
Ground Water	100	98	0.0
	1000	96	0.8
Primary Sewage Wastewater	100	100	0.7
	1000	104	2.7
Electroplating Wastewater	100	99	0.4
	1000	101	0.4

(a) Sample fortified at this concentration level.

(b) RPD - relative percent difference between duplicates.

METHOD 3511

ORGANIC COMPOUNDS IN WATER BY MICROEXTRACTION

SW-846 is not intended to be an analytical training manual. Therefore, method procedures are written based on the assumption that they will be performed by analysts who are formally trained in at least the basic principles of chemical analysis and in the use of the subject technology.

In addition, SW-846 methods, with the exception of required method use for the analysis of method-defined parameters, are intended to be guidance methods which contain general information on how to perform an analytical procedure or technique which a laboratory can use as a basic starting point for generating its own detailed standard operating procedure (SOP), either for its own general use or for a specific project application. The performance data included in this method are for guidance purposes only, and are not intended to be and must not be used as absolute QC acceptance criteria or for the purpose of laboratory accreditation.

1.0 SCOPE AND APPLICATION

For a summary of changes in this version, please see Appendix A at the end of this document.

1.1 Method 3511 is a procedure for extracting selected volatile and semivolatile organic compounds from water. The microscale approach minimizes sample size and solvent usage, thereby reducing the supply costs, health and safety risks, and waste generated.

1.2 This method was validated for several mono- and poly-cyclic aromatic hydrocarbons (MAHs and PAHs) and can be applied to any combination of these compounds.

1.3 This method also may be used to extract selected volatile organic compounds (VOCs) or semivolatile organic compounds (SVOCs) which are slightly soluble or insoluble in water at neutral pH if the extraction performance is demonstrated to be satisfactory using an appropriate analytical technique.

1.4 Prior to employing this method, analysts are advised to consult the base method for each type of procedure that may be employed in the overall analysis (e.g., Methods 3500, 3600, 5000, and 8000) for additional information on quality control procedures, development of QC acceptance criteria, calculations, and general guidance. Analysts also should consult the disclaimer statement at the front of the manual and the information in Chapter Two for guidance on the intended flexibility in the choice of methods, apparatus, materials, reagents, and supplies, and on the responsibilities of the analyst for demonstrating that the techniques employed are appropriate for the analytes of interest, in the matrix of interest, and at the levels of concern.

In addition, analysts and data users are advised that, except where explicitly required in a regulation, the use of SW-846 methods is *not* mandatory in response to Federal testing requirements. The information contained in this method is provided by EPA as guidance to be used by the analyst and the regulated community in making judgments necessary to generate results that meet the data quality objectives for the intended application.

1.5 Use of this method is restricted to use by, or under supervision of, appropriately experienced and trained personnel. Each analyst must demonstrate the ability to generate acceptable results with this method.

2.0 SUMMARY OF METHOD

2.1 Samples are prepared by liquid:liquid extraction with organic solvent in field sampling containers. Careful manipulation of the sample, solvent, and spiking solutions during the procedure minimizes loss of volatile compounds while maximizing extraction of volatile, semivolatile, and nonvolatile compounds.

2.2 Since volatile compounds are included in the method, their extraction from water requires special handling and particular attention to detail. Samples should be removed from the refrigerator shortly before extraction, and should not be allowed to warm to room temperature before the extraction solvent is added.

2.3 Samples should be prepared one at a time to the point of solvent addition (i.e., do not prepare a number of samples then add the solvent). Pay particular attention to minimizing the exposure of the sample and/or extract to air.

2.4 Determinative analysis is performed using the appropriate GC or GC/MS method (e.g., 8015, 8021 and 8270). Reference 2 shows an example of a GC configuration used for the entire list of target analytes that may help reduce solvent tailing to prevent interference with any early-eluting target compounds in this method.

3.0 DEFINITIONS

Refer to the SW-846 chapter of terms and acronyms for potentially applicable definitions.

4.0 INTERFERENCES

4.1 Solvents, reagents, glassware, and other sample processing hardware may yield artifacts and/or interferences to sample analysis. All of these materials must be demonstrated to be free from interferences under the conditions of the analysis by analyzing method blanks. Specific selection of reagents and purification of solvents by distillation in all-glass systems may be necessary. Refer to each method for specific guidance on quality control procedures and to Chapter Four for general guidance on the cleaning of glassware.

4.2 Refer to Method 3500 for additional information on interferences.

5.0 SAFETY

There are no significant safety issues specific to this method. However, SW-846 methods do not purport to address all safety issues associated with their use. The laboratory is responsible for maintaining a safe work environment and a current awareness file of OSHA regulations regarding the safe handling of the chemicals listed in this method. A reference file of material safety data sheets (MSDSs) should be available to all personnel involved in these analyses.

6.0 EQUIPMENT AND SUPPLIES

The mention of trade names or commercial products in this manual is for illustrative purposes only, and does not constitute an EPA endorsement or exclusive recommendation for use. The products and instrument settings cited in SW-846 methods represent those products and settings used during method development or subsequently evaluated by the Agency. Glassware, reagents, supplies, equipment, and settings other than those listed in this manual may be employed provided that method performance appropriate for the intended application has been demonstrated and documented.

- 6.1 VOA vials - 40-mL capacity, disposable, pre-cleaned with Polytetrafluoroethylene (PTFE)-lined caps
- 6.2 Vials - Amber glass, 2-mL capacity, with PTFE-lined screw or crimp top
- 6.3 Centrifuge - Capable of at least 500 G's
- 6.4 Syringes - gastight, contaminant-free, 2.0-mL, 1.0-mL, 10- μ L
- 6.5 Analytical balance - Capable of weighing to 0.01 g
- 6.6 Pasteur glass pipettes - 1mL, disposable

7.0 REAGENTS AND STANDARDS

7.1 Reagent grade chemicals must be used in all tests. Unless otherwise indicated, it is intended that all reagents conform to the specifications of the Committee on Analytical Reagents of the American Chemical Society, where such specifications are available. Other grades may be used, provided it is first ascertained that the reagent is of sufficiently high purity to permit its use without lessening the accuracy of the determination.

7.2 Organic-free reagent water. All references to water in this method refer to organic-free reagent water as defined in Chapter One.

7.3 Sodium sulfate (granular, anhydrous), Na_2SO_4 . Purify by heating at 400 °C for four hours in a shallow porcelain bowl. Store unused portion of sodium sulfate in a desiccator or sealed container.

7.4 Extraction and exchange solvents

The choice of solvent will depend on the analytes of interest and no single solvent is universally applicable to all analyte groups. Whatever solvent system is employed *including* those specifically listed in this method, the analyst *must* demonstrate adequate performance for the analytes of interest, at the levels of interest. At a minimum, such a demonstration will encompass the initial demonstration of proficiency described in Method 3500, using a clean reference matrix. Method 8000 describes procedures that may be used to develop performance criteria for such demonstrations as well as for matrix spike and laboratory control sample results.

All solvents should be pesticide quality or equivalent. Solvents may be degassed prior to use.

7.4.1 Methylene chloride, CH_2Cl_2 .

8.0 SAMPLE COLLECTION, PRESERVATION, AND STORAGE

See the introductory material to this chapter, Organic Analytes, Sec. 4.1.

Samples should be extracted as soon as after collection as possible, but no longer than 14 days from the date of collection for acid preserved samples. If samples are not acidified, the extraction should be performed within 7 days from date of collection.

9.0 QUALITY CONTROL

9.1 Refer to Chapter One for guidance on quality assurance (QA) and quality control (QC) protocols. When inconsistencies exist between QC guidelines, method-specific QC criteria take precedence over both technique-specific criteria and the criteria given in Chapter One, and technique-specific QC criteria take precedence over the criteria in Chapter One. Any effort involving the collection of analytical data should include development of a structured and systematic planning document, such as a Quality Assurance Project Plan (QAPP) or a Sampling and Analysis Plan (SAP), which translates project objectives and specifications into directions for those that will implement the project and assess the results. Each laboratory should maintain a formal quality assurance program. The laboratory should also maintain records to document the quality of the data generated. All data sheets and quality control data should be maintained for reference or inspection.

9.2 Initial demonstration of proficiency and lower limit of quantitation (LLOQ)

Each laboratory must demonstrate initial proficiency with each sample preparation and determinative method combination it utilizes by generating data of acceptable accuracy and precision for target analytes in a clean matrix. The laboratory must also repeat the demonstration of proficiency whenever new staff members are trained or significant changes in instrumentation are made. See Method 8000D, Sec. 9.3 for information on how to accomplish a demonstration of proficiency.

The laboratory shall establish the LLOQ as the lowest point of quantitation, which in most cases, is the lowest concentration in the calibration curve. LLOQ verification is recommended for each project application to validate quantitation capability at low analyte concentration levels. This verification may be accomplished with either clean control material (e.g., reagent water, solvent blank, Ottawa sand, diatomaceous earth, etc.) or a representative sample matrix, free of target compounds. Optimally, the LLOQ should be less than the desired regulatory action levels based on the stated DQOs.

In order to demonstrate the entire sample preparation and analysis process at the lower limit of quantitation (LLOQ), a LLOQ check standard (not part of an initial calibration) is prepared by spiking a clean control material with the analyte(s) of interest at the predicted LLOQ concentration level(s). Alternatively, a representative sample matrix may be spiked with the analytes of interest at the predicted

LLOQ concentration levels. The LLOQ check is carried through the same preparation procedures as environmental samples and other QC samples.

Recovery of target analytes in the LLOQ check standard should be within established in-house limits, or other such project-specific acceptance limits, to demonstrate acceptable method performance at the LLOQ. Until the laboratory has sufficient data to determine acceptance limits, the LCS criteria $\pm 20\%$ may be used for the LLOQ acceptance criteria. This acknowledges the poorer overall response at the low end of the calibration curve. Historically-based LLOQ acceptance criteria should be determined as soon as practical once sufficient data points have been acquired.

9.4 Refer to Method 3500 for additional quality control procedures.

9.5 Before processing any samples, the analyst should demonstrate that all parts of the equipment in contact with the sample and reagents are interference-free. This is accomplished through the analysis of a method blank. Each time samples are extracted, cleaned up, and analyzed, and when there is a change in reagents, a method blank should be prepared and analyzed for the compounds of interest as a safeguard against chronic laboratory contamination.

9.6 Any method blanks, matrix spike samples, or replicate samples should be subjected to the same analytical procedures (Sec. 11.0) as those used on actual samples.

9.7 Each extraction batch of twenty or fewer samples should include a minimum of a method blank, a laboratory control sample (LCS), a matrix spike sample, and a matrix spike duplicate or laboratory duplicate sample.

9.8 All field and QC samples should be spiked with an appropriate mix of surrogate compounds in order to track extraction efficiency.

9.9 Any QC samples should be subjected to exactly the same analytical procedures as those used on field samples.

10.0 CALIBRATION AND STANDARDIZATION

There are no calibration or standardization steps directly associated with this extraction procedure.

11.0 PROCEDURE

Refer to Sec. 9 for a list of number and types of QC samples that should be included with each batch of 20 or fewer field samples.

11.1 For each QC sample to be extracted and analyzed, prepare one vial as described below (Sec. 11.3).

11.2 If volatile compounds are target analytes of interest, the QC vials must be prepared far enough in advance that the water has time to chill before extraction. However, these vials should not be allowed to sit in the refrigerator for more than 24 hours, or their integrity may be suspect.

11.3 For each method blank or LCS QC sample, fill a 40 mL glass VOA vial with a PTFE-lined septum screw top with reagent water.

11.4 If volatile compounds are target analytes of interest, make sure that all field and QC samples are chilled to less than 4°C before proceeding.

11.5 Working with a single field or QC sample at a time, remove the cap from the VOA vial, and use a disposable pipette to remove approximately 5 mL of water. Alternatively, remove enough sample volume from the vial to prevent vessel overflow, however, too much volume removed will create a potential for headspace and loss of volatile constituents. In addition, the amount of time used to process volatile compound extracts up to the point of solvent addition needs to be kept to a minimum in order to avoid further volatile constituent losses. Replace the vial cap.

The volume removed should be disposed of according to the guidelines set forth by the laboratory for the disposal of laboratory wastes.

11.6 After removing the 5 mL, weigh the capped VOA vial for each field and QC sample. Record the weight to the nearest 0.1 grams.

11.7 Remove the cap and add 10 µg of the surrogate standard compounds in acetone. The surrogates recommended are fluorobenzene, 2-fluorobiphenyl, and 5- α -androsterone. Other compounds may be used as surrogates, depending upon the desired target analytes and project requirements.

11.7.1 It should be noted that more surrogate standard may be added to the water if the sample is suspected to be highly contaminated (i.e., the contamination may interfere with the recovery of lower concentration levels of surrogate standard).

11.7.2 The LCS and matrix spike QC samples should have 10 µg of the appropriate compounds of interest added.

11.8 Add exactly 2.0 mL of methylene chloride (DCM) (using a class A volumetric pipette or gas-tight syringe) and approximately 12 g of anhydrous sodium chloride to the VOA vial. Replace the vial cap. At this point, the next sample may be processed to the point of solvent addition and the subsequent steps performed for each sample batch.

11.9 Shake each vial vigorously for 5 minutes, or until the sodium chloride dissolves completely.

11.10 Allow the phases to separate. Centrifugation may be useful for separating the phases. If the emulsion interface between layers is more than one-third the size of the solvent layer, the analyst should employ mechanical techniques to complete the phase separation. The optimum technique depends upon the sample and may include stirring, filtration of the emulsion through glass wool, centrifugation, or other physical methods.

11.11 Using a 2.0-mL gas-tight syringe, transfer approximately 1.5 mL of the lower (DCM) layer to a 2 mL vial fitted with a PTFE lined screw cap, taking precautions to exclude any

water from the syringe. Add a small amount (~50 mg) of anhydrous sodium sulfate to the vial, cap, and shake for 2 minutes.

11.12 Using a 1.0 mL gas-tight syringe, transfer exactly 1.0 mL of the dried extract to a 2 mL vial fitted with a PTFE lined screw cap. Add 50 µg of the internal standard compounds to each vial, using an appropriate volume not to overflow the vial or dilute the extract. The internal standards recommended are *o*-terphenyl and 2,4-difluorotoluene. Other compounds may be used as internal standards, depending upon the desired target analytes and project requirements. Cap the vial and invert several times to mix the contents.

11.13 Discard the remaining contents of the VOA vials according to laboratory waste disposal guidelines. Shake off the last few drops with short, brisk wrist movements. If needed, rinse the vial with a water soluble solvent to ensure that the extraction solvent is removed. Reweigh the capped vial, and record the weight to the nearest 0.1 g. The difference between this weight, and the weight determined in Sec. 11.6 is equal to the volume of water extracted, in mL.

11.14 Extracts should be stored in the freezer or over ice until analysis.

12.0 DATA ANALYSIS AND CALCULATIONS

There are no data analysis and calculation steps directly associated with this procedure. Follow the directions given in the determinative method.

13.0 METHOD PERFORMANCE

13.1 Performance data and related information are provided in SW-846 methods only as examples and guidance. The data do not represent required performance goals for users of the methods. Instead, performance criteria should be developed on a project-specific basis, and the laboratory should establish in-house QC performance criteria for the application of this method.

13.2 Single-laboratory precision data were obtained for MAHs and PAHs at four different spiking concentrations in reagent water. Three replicates were prepared at three levels, and six replicates at one level. Extracts were analyzed by Method 8100, set up to include the MAHs along with the PAHs. Data summary tables are included in this method. For guidance purposes, the data are reported in detail in Reference 1.

14.0 POLLUTION PREVENTION

14.1 Pollution prevention encompasses any technique that reduces or eliminates the quantity and/or toxicity of waste at the point of generation. Numerous opportunities for pollution prevention exist in laboratory operations. The EPA has established a preferred hierarchy of environmental management techniques that places pollution prevention as the management option of first choice. Whenever feasible, laboratory personnel should use pollution prevention techniques to address their waste generation. When wastes cannot be feasibly reduced at the source, the Agency recommends recycling as the next best option.

14.2 For information about pollution prevention that may be applicable to laboratories and research institutions consult *Less is Better: Laboratory Chemical Management for Waste*

Reduction, a free publication available from the American Chemical Society (ACS), Committee on Chemical Safety, http://portal.acs.org/portal/fileFetch/C/WPCP_012290/pdf/WPCP_012290.pdf.

15.0 WASTE MANAGEMENT

The Environmental Protection Agency requires that laboratory waste management practices be conducted consistent with all applicable rules and regulations. The Agency urges laboratories to protect the air, water, and land by minimizing and controlling all releases from hoods and bench operations, complying with the letter and spirit of any sewer discharge permits and regulations, and by complying with all solid and hazardous waste regulations, particularly the hazardous waste identification rules and land disposal restrictions. For further information on waste management, consult *The Waste Management Manual for Laboratory Personnel* available from the American Chemical Society at the address listed in Sec. 14.2.

16.0 REFERENCES

1. "Simultaneous Analysis of Monocyclic Aromatic Hydrocarbons in Water by Microextraction." EPRI Report TR-Research Project, April 1997.
2. D. M. Munro. "Simultaneous Determination of Volatile and Semivolatile Organic Compounds in Soil." *Remediation Journal*, 10, pp. 65-81, 2000.
<http://onlinelibrary.wiley.com/doi/10.1002/rem.3440100408/pdf>

17.0 TABLES, DIAGRAMS, FLOWCHARTS, AND VALIDATION DATA

The following pages contain the tables referenced by this method.

TABLE 1

EXAMPLE MICROEXTRACTION GC/FID RECOVERY DATA FOR
MAHs AND PAHs IN REAGENT WATER SPIKED AT 8.57 µg/L¹

Compound	Sample A		Sample B		Sample C		Std. Dev. (Conc. ³)
	Conc. ²	% Rec.	Conc. ²	% Rec.	Conc. ²	% Rec.	
Benzene	9.59	112	7.40	86	8.80	103	1.1
Toluene	9.03	105	9.44	110	9.36	109	0.22
Ethylbenzene	8.60	100	8.81	103	8.87	103	0.14
m/p-Xylene	17.0	99	18.1	106	18.1	106	0.60
Styrene	6.86	80	7.17	84	6.99	82	0.16
o-Xylene	9.94	116	10.3	120	10.5	123	0.31
1,2,4-Trimethylbenzene	7.44	87	8.53	100	8.35	97	0.59
Naphthalene	7.02	82	7.36	86	7.48	87	0.24
2-Methylnaphthalene	7.11	83	7.76	91	7.96	93	0.45
1-Methylnaphthalene	7.98	93	8.45	99	8.80	103	0.41
Acenaphthylene	8.44	98	8.45	99	8.74	102	0.17
Acenaphthene	9.23	108	9.73	114	9.61	112	0.26
Dibenzofuran	6.72	78	7.01	82	6.99	82	0.16
Fluorene	6.17	72	6.62	77	7.35	86	0.60
Phenanthrene	7.43	87	7.90	92	7.74	90	0.24
Anthracene	4.76	56	6.19	72	6.24	73	0.84
Fluoranthene	8.12	95	8.53	100	8.57	100	0.25
Pyrene	8.49	99	8.78	102	8.92	104	0.22
Benz(a)anthracene	6.59	77	6.88	80	6.46	75	0.21
Chrysene	5.78	67	5.92	69	6.14	72	0.18
Benzo(b)fluoranthene ³	14.8	172	14.8	172	12.0	141	1.6
Benzo(k)fluoranthene ³	16.6	194	10.4	122	8.60	100	4.2
Benzo(a)pyrene	6.60	77	6.24	73	6.94	81	0.35
Indeno(1,2,3-cd)pyrene	5.45	64	6.16	72	5.37	63	0.43
Dibenz(a,h)anthracene	5.62	66	5.90	69	5.10	60	0.40
Benzo(g,h,i)perylene	6.15	72	6.41	75	6.50	76	0.18

¹ Three reagent water samples were spiked at 8.57 µg/L with all target compounds (in acetone), and then extracted and analyzed by the method. A small spiking volume at high analyte concentration was used to maximize the analyte/water interaction prior to the extraction step. Concentration units are µg/L.

² High compound recovery was caused by an unidentified interference, possibly a silicone compound.

TABLE 2

EXAMPLE MICROEXTRACTION GC/FID RECOVERY DATA FOR
MAHs AND PAHs IN REAGENT WATER SPIKED AT 42.9 µg/L¹

Compound	Sample A		Sample B		Sample C		Sample D		Sample E		Sample F		Std. Dev. (Conc. ³)
	Conc. ²	% Rec.	Conc. ²	% Rec.	Conc. ²	% Rec.	Conc. ²	% Rec.	Conc. ²	% Rec.	Conc. ²	% Rec.	
Benzene	45.0	105	41.3	96	29.5	69	44.9	105	43.0	100	43.6	102	5.9
Toluene	44.5	104	45.8	107	43.9	102	45.4	106	46.0	107	46.3	108	0.93
Ethylbenzene	45.9	107	47.1	110	45.7	107	47.5	111	47.7	111	48.4	113	1.1
m/p-Xylene	92.3	108	95.1	111	91.9	107	95.3	111	95.7	112	98.0	114	2.3
Styrene	40.7	95	41.9	98	40.9	95	42.1	98	42.4	99	43.4	101	1.0
o-Xylene	49.6	116	51.2	120	49.3	115	50.8	119	51.3	120	52.4	122	1.2
1,2,4-Trimethylbenzene	44.0	103	45.9	107	44.8	104	45.6	106	45.4	106	46.5	109	0.88
Naphthalene	42.8	100	44.0	103	43.2	101	43.8	102	43.7	102	43.8	102	0.45
2-Methylnaphthalene	43.3	101	44.8	105	43.6	102	43.9	103	44.3	103	43.7	102	0.54
1-Methylnaphthalene	45.4	106	46.9	109	46.0	107	46.0	107	46.3	107	45.2	106	0.58
Acenaphthylene	46.0	107	47.4	111	46.6	109	46.3	108	46.5	109	46.0	107	0.51
Acenaphthene	47.7	111	48.8	114	48.2	112	47.7	111	48.2	112	46.9	109	0.67
Dibenzofuran	43.6	102	45.0	105	44.3	103	44.0	103	44.0	103	43.3	101	0.60
Fluorene	44.8	104	45.6	106	45.4	106	44.5	104	44.7	104	44.3	103	0.53
Phenanthrene	46.1	108	47.5	111	47.3	110	46.4	108	46.9	109	46.1	107	0.61
Anthracene	37.4	87	38.6	90	38.4	90	38.0	89	37.7	88	37.4	87	0.51
Fluoranthene	46.3	108	48.0	112	48.0	112	46.9	109	47.0	110	45.9	107	0.84
Pyrene	46.5	109	48.6	113	47.7	111	47.2	110	47.4	111	47.4	111	0.68
Benz(a)anthracene	41.9	98	44.8	105	44.3	103	42.8	100	43.0	100	42.6	99	1.1
Chrysene	42.8	100	44.8	105	44.1	103	43.5	102	43.9	102	43.1	101	0.72
Benz(b)fluoranthene	47.2	110	50.6	118	49.8	116	46.9	109	48.4	113	50.8	119	1.7
Benz(k)fluoranthene	52.2	122	50.5	118	46.8	109	46.9	109	47.5	111	46.7	109	2.3
Benzo(a)pyrene	39.2	91	41.3	96	40.7	95	40.0	93	40.0	93	40.5	95	0.73
Indeno(1,2,3-cd)pyrene	49.8	116	45.7	107	38.4	89	42.7	100	42.5	99	41.3	96	3.9
Dibenz(a,h)anthracene	35.4	83	36.7	86	35.3	82	35.5	83	35.4	83	35.7	83	0.52
Benzo(g,h,i)perylene	38.3	89	39.7	93	39.2	91	38.7	90	38.5	90	38.9	91	0.50

¹ Six reagent water samples were spiked at 42.9 µg/L with all target compounds (in acetone), and then extracted and analyzed by the method. A small spiking volume at high analyte concentration was used to maximize the analyte/water interaction prior to the extraction step.

² Concentration units are µg/L.

TABLE 3

EXAMPLE MICROEXTRACTION GC/FID RECOVERY DATA FOR
MAHs AND PAHs IN REAGENT WATER SPIKED AT 857 µg/L¹

Compound	Sample A		Sample B		Sample C		Std. Dev. (Conc. ²)
	Conc. ²	% Rec.	Conc. ²	% Rec.	Conc. ²	% Rec.	
Benzene	819	96	866	101	797	93	35
Toluene	905	106	931	109	937	109	17
Ethylbenzene	922	108	933	109	978	114	30
m/p-Xylene	1840	107	1860	109	1950	114	59
Styrene	878	102	878	102	935	109	33
o-Xylene	946	110	951	111	998	116	28
1,2,4-Trimethylbenzene	933	109	928	108	991	116	35
Naphthalene	908	106	951	111	939	110	22
2-Methylnaphthalene	909	106	955	111	940	110	23
1-Methylnaphthalene	909	106	955	111	940	110	23
Acenaphthylene	905	106	962	112	937	109	29
Acenaphthene	913	107	958	112	945	110	23
Dibenzofuran	906	106	949	111	938	109	22
Fluorene	910	106	956	112	941	110	24
Phenanthrene	909	106	954	111	943	110	23
Anthracene	887	103	930	108	922	108	23
Fluoranthene	909	106	954	111	946	110	24
Pyrene	902	105	943	110	948	111	26
Benz(a)anthracene	907	106	947	110	942	110	22
Chrysene	937	109	992	116	968	113	28
Benzo(b)fluoranthene	894	104	875	102	930	108	28
Benzo(k)fluoranthene	924	108	1120	131	961	112	104
Benzo(a)pyrene	898	105	967	113	937	109	34
Indeno(1,2,3-cd)pyrene	895	104	942	110	933	109	25
Dibenz(a,h)anthracene	900	105	1010	118	941	110	56
Benzo(g,h,i)perylene	908	106	974	114	949	111	33

- ¹ Three reagent water samples were spiked at 857 µg/L with all target compounds (in acetone), and then extracted and analyzed by the method. A small spiking volume at high analyte concentration was used to maximize the analyte/water interaction prior to the extraction step.
- ² Concentration units are µg/L.

TABLE 4

EXAMPLE MICROEXTRACTION GC/FID RECOVERY DATA FOR
MAHs AND PAHs IN REAGENT WATER SPIKED AT 8570 µg/L¹

Compound	Sample A		Sample B		Sample C		Std. Dev. (Conc. ²)
	Conc. ²	% Rec.	Conc. ²	% Rec.	Conc. ²	% Rec.	
Benzene	9470	111	8770	102	9070	106	351
Toluene	8440	98	8710	102	8510	99	140
Ethylbenzene	8750	102	8860	103	8860	103	64
m/p-Xylene	17500	102	17700	103	17700	103	115
Styrene	NA	NC	NA	NC	NA	NC	NC
o-Xylene	8810	103	8910	104	8910	104	58
1,2,4-Trimethylbenzene	8840	103	8940	104	8950	104	61
Naphthalene	8520	99	8800	103	8480	99	174
2-Methylnaphthalene	8400	98	8880	104	8540	100	247
1-Methylnaphthalene	8420	98	8890	104	8540	100	244
Acenaphthylene	8490	99	8750	102	8440	98	167
Acenaphthene	8520	99	8790	103	8470	99	172
Dibenzofuran	8450	99	8930	104	8600	100	246
Fluorene	8550	100	8820	103	8510	99	169
Phenanthrene	8680	101	8940	104	8640	101	163
Anthracene	8230	96	8480	99	8150	95	172
Fluoranthene	8560	100	8820	103	8520	99	163
Pyrene	8630	101	8910	104	8600	100	171
Benz(a)anthracene	8630	101	8890	104	8610	100	156
Chrysene	8450	99	8750	102	8400	98	189
Benzo(b)fluoranthene	8850	103	9110	106	8810	103	163
Benzo(k)fluoranthene	8420	98	8660	101	8380	98	151
Benzo(a)pyrene	8700	102	8960	105	8660	101	163
Indeno(1,2,3-cd)pyrene	9480	111	9670	113	9480	111	110
Dibenz(a,h)anthracene	8550	100	8970	105	8540	100	245
Benzo(g,h,i)perylene	8990	105	9310	109	9030	105	174

NA = Not available

NC = Not calculated

¹ Three reagent water samples were spiked at 8570 µg/L with all target compounds (in acetone), and then extracted and analyzed by the method. A small spiking volume at high analyte concentration was used to maximize the analyte/water interaction prior to the extraction step.

² Concentration units are µg/L.

Appendix A:

Summary of Revisions to Method 3511 (as compared to previous Revision 0, November 2002)

1. Improved overall method formatting for consistency with new SW-846 methods style guidance. The format was updated to Microsoft Word.docx.
2. Minor editorial and technical revisions were made throughout to improve method clarity.
3. The revision number was changed to 1 and the date published was changed to July 2014.
4. This appendix was added showing changes from the previous revision.
5. Added Updated IDP language and LLOQ verification standard language to Secs. 9.2 and 9.3.
6. Added a reference in Sec. 16.

FS 2200. Groundwater Sampling

1. INTRODUCTION AND SCOPE

1.1 Use these Standard Operating Procedures to collect groundwater samples. They are designed to ensure that the collected samples will be representative of water in the aquifer or target formation and that the samples have not been altered or contaminated by the sampling and handling procedures. These procedures apply to permanently and temporarily installed monitoring wells, wells constructed using "direct-push" techniques, wells with installed plumbing, remedial groundwater treatment systems and excavations where groundwater is present. Use of alternative, DEP-approved and properly documented procedures (e.g., Corporate SOP, ASTM Standards, alternative equipment, etc.) is acceptable if they meet the intent (e.g., sample representativeness and integrity) of this standard (see FA 1000).

1.2 The topics in this SOP include equipment and supply selection, equipment construction materials, and purging and sampling techniques.

1.3 Use the following DEP SOPs in conjunction with FS 2200:

- FA 1000 Regulatory Scope and Administrative Procedures for Use of DEP SOPs
- FC 1000 Cleaning/Decontamination Procedures
- FD 1000 Documentation Procedures
- FQ 1000 Field Quality Control Requirements
- FS 1000 General Sampling Procedures
- FS 2000 General Aqueous Sampling
- FT 1000 Field Testing and Measurement
- FT 1100 Field pH
- FT 1200 Field Specific Conductance
- FT 1400 Field Temperature
- FT 1500 Field Dissolved Oxygen
- FT 1600 Field Turbidity

2. Groundwater samples may be collected from a number of different configurations. Each configuration is associated with a unique set of sampling equipment requirements and techniques:

3. Wells without Plumbing: These wells require that equipment be brought to the well to purge and sample unless dedicated equipment is placed in the well.

4. Wells with In-Place Plumbing: Wells with in-place plumbing do not require that equipment be brought to the well to purge and sample. In-place plumbing is generally considered permanent equipment routinely used for purposes other than purging and sampling, such as for water supply. They are generally found at wellfields, industrial facilities, and private residences. See FS 2300 for procedures to sample potable water wells. Air Strippers or Remedial Systems: These types of systems are installed as remediation devices. Sample these wells like drinking water wells (see FS 2300).

FS 2201 *Equipment and Supplies*

Use groundwater purging and sampling equipment constructed of only non-reactive, non-leachable materials that are compatible with the environment and the selected analytes. In selecting groundwater purging and sampling equipment, give consideration to the depth of the

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well, the depth to groundwater, the volume of water to be evacuated, the sampling and purging technique, and the analytes of interest. Refer to Tables FS 1000-1, FS 1000-2, FS 1000-3 and FS 2200-1 for selection of appropriate equipment.

Additional supplies such as reagents, preservatives, and field measurement equipment are often necessary.

1. **FLOW CONTAINER:** DEP recommends using a flow-through cell or container when collecting measurements for purging stabilization. The design must ensure that fresh formation water continuously contacts the measuring devices and does not aerate the sample or otherwise affect the groundwater properties.
2. **PUMPS:** All pumps or pump tubing must be lowered and retrieved from the well slowly and carefully to minimize disturbance to the formation water. This is especially critical at the air/water interface. Avoid the resuspension of sediment particles (turbidity) at the bottom of the well or adhered to the well casing during positioning of the pump or tubing.

2.1 Above-Ground Pumps

2.1.1 Variable Speed Peristaltic Pump: Use a variable speed peristaltic pump to purge groundwater from wells when the static water level in the well is no greater than 20-25 feet below land surface (BLS). If the water levels are deeper than 18-20 feet BLS, the pumping velocity will decrease.

2.1.1.1 A variable speed peristaltic pump can be used for normal purging and sampling (see FS 2213 and FS 2221), sampling low permeability aquifers or formations (see FS 2222) and collecting filtered groundwater samples (see FS 2225, section 1).

2.1.1.2 Most analyte groups can be sampled with a peristaltic pump if the tubing and pump configurations are appropriate. See Table FS 1000-3 for proper tubing selection and pump configurations.

2.1.2 Variable Speed Centrifugal Pump: A variable speed centrifugal pump can be used to purge groundwater from 2-inch and larger internal diameter wells. Do not use this type of pump to collect groundwater samples.

2.1.2.1 When purging is complete, do not allow the water that remains in the tubing to fall back into the well. Install a check valve at the end of the purge tubing, and withdraw the tubing slowly from the well while the pump is still running.

2.1.2.2 See Table FS 1000-3 for proper tubing selection and allowable analyte groups.

2.2 Submersible Pumps

2.2.1 Variable Speed Electric Submersible Pump: A variable speed submersible pump can be used to purge and sample groundwater from 2-inch and larger internal diameter wells.

2.2.1.1 A variable speed submersible pump can be used for normal purging and sampling (see FS 2213 and FS 2221), sampling low permeability aquifers or formations (see FS 2222) and collecting filtered groundwater samples (see FS 2225, section 1).

2.2.1.2 Make sure that the pump housing, fittings, check valves and associated hardware are constructed of stainless steel. Make sure that any other materials are compatible with the analytes of interest. See Table FS 1000-3 for restrictions.

2.2.1.3 Install a check valve at the output side of the pump to prevent backflow.

2.2.1.4 If purging and sampling for organics:

- The entire length of the delivery tube must be Teflon, Polyethylene or Polypropylene tubing. Do not use low-density polyethylene for the collection of samples for analysis of volatile organic compounds (VOCs).
- The electrical cord must be sealed in Teflon, Polyethylene or Polypropylene and any cabling must be sealed in Teflon, Polyethylene or Polypropylene, or be constructed of stainless steel.
- All interior components that contact the sample water (impeller, seals, gaskets, etc.) must be constructed of stainless steel or Teflon.

2.2.2 Variable Speed Bladder Pump: A variable speed positive displacement bladder pump (no-gas contact) can be used to purge and sample groundwater from 3/4-inch and larger internal diameter wells.

2.2.2.1 A variable speed bladder pump can be used for normal purging and sampling (see FS 2213 and FS 2221), sampling low permeability aquifers or formations (see FS 2222) and collecting filtered groundwater samples (see FS 2225, section 1).

2.2.2.2 The bladder pump system is composed of the pump, the compressed air tubing, the water discharge tubing, the controller and a compressor or compressed gas supply.

2.2.2.3 The pump consists of a bladder and an exterior casing or pump body that surrounds the bladder and two (2) check valves. These parts can be composed of various materials, usually combinations of polyvinyl chloride (PVC), Teflon, Polyethylene, and stainless steel. Other materials must be compatible with the analytes of interest. See Table FS 1000-3 for restrictions.

2.2.2.4 If purging and sampling for organics:

- The pump body must be constructed of stainless steel and the valves and bladder must be Teflon, Polyethylene or Polypropylene.
- The entire length of the delivery tube must be Teflon, Polyethylene or Polypropylene. Do not use low-density polyethylene for VOCs.
- Any cabling must be sealed in Teflon, Polyethylene or Polypropylene, or be constructed of stainless steel.
- Permanently installed pumps may have a PVC pump body as long as the pump remains in contact with the water in the well.

3. BAILERS:

3.1 Purging: DEP does not recommend using bailers for purging unless no other equipment can be used or purging with a bailer has been specifically authorized by a DEP program, permit, contract or order (see Table FS 2200-3). Use a bailer if there is non-aqueous phase liquid (free product) in the well or non-aqueous phase liquid is suspected to be in the well. If in doubt about the appropriateness of using a bailer at a site or during a particular sampling event, contact the appropriate DEP program or project manager. If a bailer is used, follow FS 2213, section 4, with no deviations.

3.2 Sampling: Bailers may be used to routinely collect some analyte groups or under specific circumstances for other analyte groups (see Table FS 2200-3).

3.3 Construction and Type:

3.3.1 Bailers must be constructed of materials compatible with the analytes of interest. See Table FS 1000-3 for restrictions.

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- 3.3.2 Stainless steel, Teflon, Polyethylene and Polypropylene bailers may be used to sample all analytes. Low-density polyethylene is not suitable for the collection of VOCs.
- 3.3.3 Use disposable bailers when sampling grossly contaminated sample sources.
- 3.3.4 DEP recommends using dual check valve bailers when collecting samples.
- 3.3.5 Use bailers with a controlled flow bottom when collecting volatile organic samples.
- 3.3.6 Use bailers that can be pressurized when collecting filtered samples for metals.

3.4 Contamination Prevention:

- 3.4.1 Keep the bailer wrapped (foil, butcher paper, etc.) until just before use.
- 3.4.2 Use protective gloves to handle the bailer once it is removed from its wrapping.
- 3.4.3 Handle the bailer by the lanyard to minimize contact with the bailer surface.

4. LANYARDS

- 4.1 Lanyards must be made of non-reactive, non-leachable material such as cotton twine, nylon, or stainless steel; or, coated with Teflon, Polyethylene or Polypropylene.
 - 4.1.1 Evaluate the appropriateness of the lanyard material with analyses of equipment blanks for the analytes of interest, as necessary.
- 4.2 Discard cotton twine, nylon, and non-stainless steel braided lanyards after sampling each monitoring well.
- 4.3 Decontaminate stainless steel, coated Teflon, Polyethylene and Polypropylene lanyards between monitoring wells (see FC 1003). They do not need to be decontaminated between purging and sampling operations.
- 4.4 Securely fasten lanyards to downhole equipment (bailers, pumps, etc.).
- 4.5 Do not allow lanyards used for downhole equipment to touch the ground surface.

FS 2210. GROUNDWATER PURGING

Perform procedures in the following sections to calculate purging parameters and to purge groundwater from monitoring wells, wells with installed plumbing, high-volume wells, air stripper systems and other remedial treatment systems.

FS 2211 *Water Level and Purge Volume Determination*

Collect representative groundwater samples from the aquifer. The amount of water that must be purged from a well is determined by the volume of water and/or field parameter stabilization.

1. GENERAL EQUIPMENT CONSIDERATIONS

- 1.1 Selection of appropriate purging equipment depends on the analytes of interest, the well diameter, transmissivity of the aquifer, the depth to groundwater and other site conditions.
- 1.2 Use a pump to purge the well.
- 1.3 Use a bailer if there is non-aqueous phase liquid in the well or non-aqueous phase liquid is suspected to be in the well.
- 1.4 Bailers may be used if approved by a DEP program, or if bailer use is specified in a permit, contract or DEP order (see Table FS 2200-3). If used, bailers must be of appropriate type and construction, and the user must follow the procedure outlined in FS 2213, section 4, with no deviations. If in doubt about the appropriateness of using a bailer at a site or during a particular sampling event, contact the appropriate DEP program or project manager. DEP does not recommend using bailers because improper bailing:

- 1.4.1 Introduces atmospheric oxygen which precipitates metals (i.e., iron) or causes other changes in the chemistry of the water in the sample (i.e., pH)
- 1.4.2 Agitates groundwater which biases volatile and semi-volatile organic analyses due to volatilization
- 1.4.3 Agitates the water in the aquifer and resuspends fine particulate matter
- 1.4.4 Surges the well, loosening particulate matter in the annular space around the well screen
- 1.4.5 Introduces dirt into the water column if the sides of the casing wall are scraped

2. INITIAL INSPECTION

- 2.1 Verify the identification of the monitoring well by examining markings, sign plates, placards or other designations.
- 2.2 Remove the well cover and remove all standing water around the top of the well casing (manhole) before opening the well cap.
- 2.3 Inspect the exterior protective casing of the monitoring well for damage and document the results of the inspection if there is a problem.
- 2.4 It is recommended that you place a protective covering around the well head. Replace the covering if it becomes soiled or ripped.
- 2.5 Inspect the well lock and determine whether the cap fits tightly. Replace the cap if necessary.

3. WATER LEVEL MEASUREMENTS: Use an electronic probe or chalked tape to determine the water level.

3.1 General Procedures

Perform these steps using either the electronic probe or chalked tape method.

- 3.1.1 Decontaminate all equipment that will contact the groundwater in the well before use.
- 3.1.2 Measure the depth to groundwater from the top of well casing to the nearest 0.01 foot and always measure from the same reference point or survey mark on the well casing. If there is no reference mark, measure from the north side of the casing.
- 3.1.3 Record the measurement and the reference point.

3.2 Electronic Probe

- 3.2.1 Follow the manufacturer's instructions for use.
- 3.2.2 Record the measurement.

3.3 Chalked Line Method: This method is not recommended if collecting samples for organic or inorganic parameters.

- 3.3.1 Lower chalked tape into the well until the lower end is in the water (usually determined by the sound of the weight hitting the water).
- 3.3.2 Record the length of the tape relative to the reference point (see section 3.2 above).
- 3.3.3 Quickly remove the tape from the well.
- 3.3.4 Record the length of the wetted portion to the nearest 0.01 foot.
- 3.3.5 Determine the depth to water by subtracting the length of the wetted portion (see section 3.5.3 above) from the total length (see section 3.5.2 above). Record the result.

4. WATER COLUMN DETERMINATION

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4.1 Do not determine the total depth of the well by lowering the probe to the bottom of the well immediately before purging and sampling. If the well must be sounded, delay purging and sampling activities for at least 24 hours after the well was sounded or for a time sufficient to meet the purge stabilization criterion for turbidity. Alternatively, collect samples before sounding the well.

4.2 Subtract the depth to the top of the water column from the total well depth to determine the length of the water column.

4.3 The total well depth depends on the well construction. Some wells may be drilled in areas of sinkhole or karst formations or rock leaving an open borehole. Attempt to find the total borehole depth in cases where there is an open borehole below the cased portion.

5. WELL WATER VOLUME

5.1 Calculate the total volume of water in gallons in the well using the following equation:

$$V = (0.041)d \times d \times h$$

Where: V = volume in gallons
d = well diameter in inches
h = height of the water column in feet

5.2 The total volume of water in the well may also be determined with the following equation by using a casing volume per foot factor (Gallons per Foot of Water) for the appropriate diameter well:

$$V = [\text{Gallons per Foot of Water}] \times h$$

Where: V = volume in gallons
h = height of the water column in feet

Casing Internal Diameter	Approximate Gallons per Foot of Water
0.75"	0.02
1"	0.04
1.25"	0.06
2"	0.16
3"	0.37
4"	0.65
5"	1.02
6"	1.47
12"	5.88

5.3 Record all measurements and calculations in the field records.

6. Purging Equipment Volume

Calculate the total volume of the pump, associated tubing and container that is used for in situ measurements (flow container), if used, using the following equation:

$$V = p + ((0.041)d \times d \times l) + fc$$

Where: V = volume in gallons

p = volume of pump in gallons
d = tubing diameter in inches
l = length of tubing in feet
fc = volume of flow cell in gallons

7. When collecting samples from multiple wells on a site, if the groundwater elevation data are to be used to construct groundwater elevation contour maps, all water level measurements must be taken within the same 24-hour time interval unless a shorter time period is required by a DEP program. If the site is tidally influenced, complete the water level measurements within the time frame of an incoming or outgoing tide.

FS 2212 Well Purging Techniques

The selection of the purging technique and equipment is dependent on the hydrogeologic properties of the aquifer, especially depth to groundwater and hydraulic conductivity. The intent of proper purging is to stabilize the water level in the well and minimize the hydraulic stress to the hydrogeologic formation.

Every attempt must be made to match the pumping rate with the recharge rate of the well before evaluating the purging completion criteria.

A flowchart which summarizes purging procedure options is presented in Figure FS 2200-2.

Select equipment using the construction and configuration requirements specified in Table FS 2200-1. See the discussions in FS 2201.

1. MEASURING THE PURGE VOLUME: The volume of water that is removed during purging must be recorded. Measure the volume during the purging operation.

1.1 Collect the water in a graduated container and multiply the number of times the container was emptied by the volume of the container, or

1.2 Estimate the volume based on pumping rate. Use this technique only if the pumping rate is constant. Determine the pumping rate by measuring the amount of water that is pumped for a fixed period of time or use a flow meter.

1.2.1 Calculate the amount of water that is discharged per minute:

$$D = \frac{\text{Measured amount}}{\text{Total time in minutes}}$$

1.2.2 Calculate the time needed to purge one (1) well volume or one (1) purging equipment volume:

$$\text{Time} = \frac{V}{D}$$

Where: V = well volume determined from FS 2211, section 5, or purging equipment volume

D = discharge rate calculated in section 1.2.1. above

1.2.3 Make new measurements (see section 1.2.1 above) each time the pumping rate is changed, or

1.3 Use a totalizing flow meter.

1.3.1 Record the reading on the totalizer prior to purging.

1.3.2 Record the reading on the totalizer at the end of purging.

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1.3.3 Subtract the reading on the totalizer prior to purging from the reading on the totalizer at the end of purging to obtain the volume purged.

1.4 Record in the field records the times that purging begins and ends.

2. Stabilization Measurement Frequency

2.1 Begin to record stabilization measurements after pumping the minimum volume as prescribed in options 2.3 – 2.5 below. Every attempt must be made to match the pumping rate with the recharge rate of the well before evaluating the purging criteria.

2.2 If the well screened interval is not known, use option 2.3, below.

2.3 Wells with Fully Submerged Screen and Pump or Intake Tubing Placed at the Top of the Water Column (conventional purge): Purge until the water level has stabilized (well recovery rate equals the purge rate), then purge a minimum of one (1) well volume prior to collecting measurements of the stabilization parameters. Allow at least one quarter (1/4) well volume to purge between subsequent measurements.

2.4 Wells with Fully Submerged Screen and Pump or Intake Tubing Placed Within the Screened Interval (minimizing purge volume): Purge until the water level has stabilized (well recovery rate equals the purge rate), then purge a minimum of one (1) volume of the pump, associated tubing and flow container (if used) prior to collecting measurements of the stabilization parameters. Take measurements of the stabilization parameters no sooner than two (2) minutes apart. Purge at least three (3) volumes of the pump, associated tubing and flow container, if used, prior to collecting a sample.

If the water level drops into the screened interval during purging, lower the pump or tubing intake as in FS 2213, section 1.3 below and follow purging procedures for partially submerged well screens (2.5 below).

2.5 Wells with a Partially Submerged Well Screen: Purge until the water level has stabilized (well recovery rate equals the purge rate), then purge a minimum of one (1) well volume prior to collecting measurements of the stabilization parameters. Take measurements of the stabilization parameters no sooner than two (2) minutes apart.

3. PURGING COMPLETION: DEP recommends the use of a flow-through container to measure the stabilization parameters discussed below. Alternatively, measure all parameters *in situ* by inserting measurement probes into the well at the depth appropriate for the purging option. Purging is considered complete if the criteria in section 3.1, 3.2 or 3.3 below are satisfied. Make every attempt to satisfy the criteria in section 3.1. Every attempt must be made to match the pumping rate with the recharge rate of the well before evaluating the purging criteria.

3.1 Three (3) consecutive measurements of the five (5) parameters listed below must be within the stated limits. The measurements evaluated must be the last three consecutive measurements taken before purging is stopped. The range between the highest and the lowest values for the last three measurements of temperature, pH and specific conductance cannot exceed the stated limits. The last three consecutive measurements of dissolved oxygen and turbidity must all be at or below the listed thresholds.

- Temperature: $\pm 0.2^{\circ} \text{C}$
- pH: ± 0.2 Standard Units
- Specific Conductance: $\pm 5.0\%$ of reading
- Dissolved Oxygen: $\leq 20\%$ Saturation
- Turbidity: ≤ 20 NTU

3.2 Naturally occurring conditions may prevent attaining the $\leq 20\%$ saturation criterion for dissolved oxygen, typically in surficial aquifers. See section 3.5, below.

3.3 Naturally occurring conditions may prevent attaining the ≤ 20 NTU criterion for turbidity. However, when collecting groundwater samples for metals or certain inorganic (e.g., phosphorus forms) or extractable organic (e.g. polynuclear aromatic hydrocarbons) chemicals, make every attempt to reduce turbidity to ≤ 20 NTU to avoid a potential turbidity-associated bias for these analytes. See section 3.5, below.

3.4 Document and report the following, as applicable, except that the last four (4) items only need to be submitted once:

- Purging rate.
- Drawdown in the well, if any.
- Pump or tubing intake placement.
- Length and location of the screened interval.
- A description of the process and the data used to design the well.
- The equipment and procedure used to install the well.
- The well development procedure.
- Pertinent lithologic or hydrogeologic information.

3.5 If the criteria in section 3.1 above for dissolved oxygen and/or turbidity cannot be met, then three (3) consecutive measurements of the five (5) parameters listed below must be within the stated limits.

3.5.1 The measurements evaluated must be the last three consecutive measurements taken before purging is stopped. The range between the highest and the lowest values for the last three measurements cannot exceed the stated limits.

- Temperature: $\pm 0.2^{\circ}\text{C}$
- pH: ± 0.2 Standard Units
- Specific Conductance: $\pm 5.0\%$ of reading
- Dissolved Oxygen: ± 0.2 mg/L or 10%, whichever is greater
- Turbidity: ± 5 NTUs or 10%, whichever is greater

3.5.2 Additionally, document and report the following, as applicable, except that the last four (4) items only need to be submitted once:

- Purging rate.
- Drawdown in the well, if any.
- Pump or tubing intake placement.
- Length and location of the screened interval.
- A description of conditions at the site that cause the dissolved oxygen to be high and/or dissolved oxygen measurements made within the screened or open borehole portion of the well with a downhole dissolved oxygen probe.
- A description of conditions at the site that cause the turbidity to be high and any procedures that will be used to minimize turbidity in the future.
- A description of the process and the data used to design the well.
- The equipment and procedure used to install the well.
- The well development procedure.
- Pertinent lithologic or hydrogeologic information.

3.5.3 If from review of the submitted data the Department determines that both the elevated Dissolved Oxygen and Turbidity measurements are due to naturally occurring

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conditions, then only the first four (4) items are required to be submitted in future reports. However, if the Department cannot determine if the Dissolved Oxygen or Turbidity is elevated due to naturally occurring conditions, then in addition to the first four (4) items, a description of the conditions at the site that caused the affected parameter(s) to be high is required to be submitted in future reports.

3.6 If the stabilization parameters in either section 3.1 or 3.2 cannot be met, and all attempts have been made to minimize the drawdown, check the instrument condition and calibration, purging flow rate and all tubing connections to determine if they might be affecting the ability to achieve stable measurements. All measurements that were made during the attempt must be documented. The sampling team leader may decide whether or not to collect a sample or to continue purging after five (5) well volumes (conventional purge section 2.1 or 2.3 above) or five (5) volumes of the screened interval (minimizing purge volumes in section 2.2 above).

Further, the report in which the data are submitted must include the following, as applicable, except that the last four (4) items only need to be submitted once:

- Purging rate.
- Pump or tubing intake placement.
- Length and location of the screened interval.
- Drawdown in the well, if any.
- A description of conditions at the site that caused the dissolved oxygen to be high and/or dissolved oxygen measurements made within the screened or open borehole portion of the well with a downhole dissolved oxygen probe.
- A description of conditions at the site that caused the turbidity to be high and any procedures that will be used to minimize turbidity in the future.
- A description of the process and the data used to design the well.
- The equipment and procedure used to install the well.
- The well development procedure.
- Pertinent lithologic or hydrogeologic information.

If from review of the submitted data the DEP determines that both the elevated Dissolved Oxygen and Turbidity measurements are due to naturally occurring conditions, then only the first four (4) items are required to be submitted in future reports. However, if the DEP cannot determine if the Dissolved Oxygen or Turbidity is elevated due to naturally occurring conditions, then in addition to the first four (4) items, a description of the conditions at the site that caused the affected parameter(s) to be high is required to be submitted in future reports.

3.7 One fully dry purge (not recommended). This criterion applies only if purging was attempted per FS 2212, FS 2213, and section 3.4.1 below, and if it is impossible to balance the pumping rate with the rate of recharge at very low pumping rates (< 100 mL/minute).

3.7.1 If wells have previously and consistently purged dry, when purged according to FS 2212 and FS 2213, and the current depth to groundwater indicates that the well will purge dry during the current sampling event, minimize the amount of water removed from the well by using the same pump to purge and collect the sample:

3.7.1.1 Place the pump or tubing intake within the well screened interval.

3.7.1.2 Use very small diameter Teflon, Polyethylene or Polypropylene tubing and the smallest possible pump chamber volume to minimize the total volume of

water pumped from the well and to reduce drawdown. If samples will be collected for VOCs, do not use low-density polyethylene tubing.

3.7.1.3 Select tubing that is thick enough to minimize oxygen transfer through the tubing walls while pumping.

3.7.1.4 Pump at the lowest possible rate (100 mL/minute or less) to reduce drawdown to a minimum.

3.7.1.5 Purge at least two (2) volumes of the pumping system (pump, tubing and flow cell, if used).

3.7.1.6 Measure pH, Specific Conductance, Temperature, Dissolved Oxygen and Turbidity and begin to collect the samples (see FS 2222).

4. Collect samples immediately after purging is complete.

4.1 The time period between completing the purge and sampling cannot exceed six (6) hours.

4.2 If sample collection does not occur within one (1) hour of purging completion, re-measure the five (5) field parameters Temperature, pH, Specific Conductance, Dissolved Oxygen and Turbidity just prior to collecting the sample.

4.2.1 If the measured values are not within 10 percent of the previous measurements, re-purge the well.

4.2.2 See section 3.4 above when collecting samples from wells that have purged dry.

FS 2213 *Purging Wells Without Plumbing (Monitoring Wells)*

1. TUBING/PUMP PLACEMENT

1.1 Do not lower the pump or intake hose (tubing) to the bottom of the well. Pump or tubing placement procedures will be determined by the purging option selected in FS 2212, section 2 above or FS 2214 below.

1.1.1 Minimizing Purge Volume: If the following conditions can be met, position the intake hose (tubing) or pump in the screened or open borehole interval.

- The same pump must be used for both purging and sampling,
- The well screen or borehole interval must be less than or equal to 10 feet, and
- The well screen or borehole must be fully submerged.

1.1.2 If the position or length of the screened interval or open borehole is unknown or estimated, place the intake hose (tubing) or pump to perform conventional purging in 1.2 below.

1.1.3 Position the pump or intake hose when purging large-diameter deep wells with open boreholes using the procedure in FS 2214 below.

1.2 Conventional Purging: Position the pump or intake tubing in the top one foot of the water column or no deeper than necessary for the type of pump.

1.2.1 If purging with a bailer, see section 4 below.

1.3 Partially Submerged Screened Interval: If the well screen or open borehole is partially submerged, and the pump will be used for both purging and sampling, position the pump or intake hose (tubing) in the portion of the water column within the submerged screened or open borehole interval.

1.3.1 If the position or length of the screened interval or open borehole is unknown or estimated, place the intake hose (tubing) or pump to perform conventional purging in 1.2 above.

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- 1.3.2 Purge large-volume, high-recharge wells as in FS 2214 below.
- 1.3.3 If purging with a bailer, see section 4 below.
- 2. NON-DEDICATED (PORTABLE) PUMPS
 - 2.1 Variable Speed Peristaltic Pump
 - 2.1.1 Install a new, 1-foot maximum length of silicone tubing in the peristaltic pump head.
 - 2.1.2 Attach a short section of tubing to the discharge side of the pump-head silicone tubing and into a graduated container.
 - 2.1.3 Attach one end of a length of new or precleaned transport tubing to the intake side of the pump head silicone tubing.
 - 2.1.4 Place the transport tubing in the monitoring well per one of the options in FS 2213, section 1 above.
 - 2.1.5 Measure the depth to groundwater at frequent intervals.
 - 2.1.6 Record these measurements.
 - 2.1.7 Adjust the purging rate so that it is equivalent to the well recovery rate to minimize drawdown.
 - 2.1.8 If the purging rate exceeds the well recovery rate, reduce the pumping rate to balance the withdrawal rate with the recharge rate.
 - 2.1.9 If the water table continues to drop during pumping, lower the tubing at the approximate rate of drawdown so that the water is removed from the top of the water column.
 - 2.1.10 Record the purging rate each time the rate changes.
 - 2.1.11 Measure the purge volume by one of the methods outlined in FS 2212, section 1.
 - 2.1.12 Record this measurement.
 - 2.1.13 Decontaminate the pump and tubing between wells (see FC 1000) or only the pump if precleaned tubing is used for each well.
 - 2.2 Variable Speed Centrifugal Pump
 - 2.2.1 Position fuel powered equipment **downwind** and at least 10 feet from the well head. Make sure that the exhaust faces downwind.
 - 2.2.2 Place the decontaminated suction hose so that water is always pumped from the top of the water column.
 - 2.2.3 Equip the suction hose with a foot valve to prevent purge water from re-entering the well.
 - 2.2.4 Measure the depth to groundwater at frequent intervals.
 - 2.2.5 Record these measurements.
 - 2.2.6 Adjust the purging rate so that it is equivalent to the well recovery rate to minimize drawdown.
 - 2.2.7 If the purging rate exceeds the well recovery rate, reduce the pumping rate to balance the withdrawal rate with the recharge rate.
 - 2.2.8 If the water table continues to drop during pumping, lower the tubing at the approximate rate of drawdown so that the water is removed from the top of the water column.
 - 2.2.9 Record the purging rate each time the rate changes.
 - 2.2.10 Measure the purge volume by one of the methods outlined in FS 2212, section 1.

2.2.11 Record this measurement.

2.2.12 Decontaminate the pump and tubing between wells (see FC 1000) or only the pump if precleaned tubing is used for each well.

2.3 Variable Speed Electric Submersible Pump

2.3.1 Position fuel powered equipment downwind and at least 10 feet from the well head. Make sure that the exhaust faces downwind.

2.3.2 Carefully position the decontaminated pump per one of the options in FS 2213, section 1 above.

2.3.3 Measure the depth to groundwater at frequent intervals.

2.3.4 Record these measurements.

2.3.5 Adjust the purging rate so that it is equivalent to the well recovery rate to minimize drawdown.

2.3.6 If the purging rate exceeds the well recovery rate, reduce the pumping rate to balance the withdrawal rate with the recharge rate.

2.3.7 If the water table continues to drop during pumping, lower the tubing or pump at the approximate rate of drawdown so that the water is removed from the top of the water column.

2.3.8 Record the purging rate each time the rate changes.

2.3.9 Measure the purge volume by one of the methods outlined in FS 2212, section 1.

2.3.10 Record this measurement.

2.3.11 Decontaminate the pump and tubing between wells (see FC 1000) or only the pump if precleaned tubing is used for each well.

2.4 Variable Speed Bladder Pump

2.4.1 Position fuel powered equipment **downwind** and at least 10 feet from the well head. Make sure that the exhaust faces downwind.

2.4.2 Attach the tubing and carefully position the pump per one of the options in FS 2213, section 1 above.

2.4.3 Measure the depth to groundwater at frequent intervals.

2.4.4 Record these measurements.

2.4.5 Adjust the purging rate so that it is equivalent to the well recovery rate to minimize drawdown.

2.4.6 If the purging rate exceeds the well recovery rate, reduce the pumping rate to balance the withdrawal rate with the recharge rate.

2.4.7 If the water table continues to drop during pumping, lower the tubing or pump at the approximate rate of drawdown so that the water is removed from the top of the water column.

2.4.8 Record the purging rate each time the rate changes.

2.4.9 Measure the purge volume by one of the methods outlined in FS 2212, section 1.

2.4.10 Record this measurement.

2.4.11 Decontaminate the pump and tubing between wells (see FC 1000) or only the pump if precleaned tubing is used for each well.

3. DEDICATED PORTABLE PUMPS: Place dedicated pumps per one of the options in FS 2213, section 1 above.

3.1 Variable Speed Electric Submersible Pump

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- 3.1.1 Position fuel powered equipment **downwind** and at least 10 feet from the well head. Make sure that the exhaust faces downwind.
- 3.1.2 Measure the depth to groundwater at frequent intervals.
- 3.1.3 Record these measurements.
- 3.1.4 Adjust the purging rate so that it is equivalent to the well recovery rate to minimize drawdown.
- 3.1.5 If the purging rate exceeds the well recovery rate, reduce the pumping rate to balance the withdrawal with the recharge rate.
- 3.1.6 Record the purging rate each time the rate changes.
- 3.1.7 Measure the purge volume by one of the methods outlined in FS 2212, section 1.
- 3.1.8 Record this measurement.

3.2 Variable Speed Bladder Pump

- 3.2.1 Position fuel powered equipment **downwind** and at least 10 feet from the well head. Make sure that the exhaust faces downwind.
- 3.2.2 Measure the depth to groundwater at frequent intervals.
- 3.2.3 Record these measurements.
- 3.2.4 Adjust the purging rate so that it is equivalent to the well recovery rate to minimize drawdown.
- 3.2.5 If the purging rate exceeds the well recovery rate, reduce the pumping rate to balance the withdrawal with the recharge rate.
- 3.2.6 Record the purging rate each time the rate changes.
- 3.2.7 Measure the purge volume by one of the methods outlined in FS 2212, section 1.
- 3.2.8 Record this measurement.

4. BAILERS: DEP recommends against using bailers for purging except as a last contingency, or if free product is present in the well or suspected to be in the well. However, they may be used if approved by a DEP program, or specified in a permit, contract or DEP order (see Table FS 2200-3 and FS 2211, section 1.3). If in doubt about the appropriateness of using a bailer at a site or during a particular sampling event, contact the appropriate DEP program or project manager.

- 4.1 Minimize handling the bailer as much as possible.
 - 4.1.1 Remove the bailer from its protective wrapping just before use.
 - 4.1.2 Attach a lanyard of appropriate material (see FS 2201, section 4).
 - 4.1.3 Use the lanyard to move and position the bailer.
- 4.2 Lower and retrieve the bailer slowly and smoothly.
- 4.3 Lower the bailer carefully into the well to a depth approximately a foot above the water column.
 - 4.3.1 Do not lower the top of the bailer more than one (1) foot below the top of the water table so that water is removed from the top of the water column. Ensure that the length of the bailer does not exceed the length of the water column.
 - 4.3.2 Allow time for the bailer to fill with aquifer water as it descends into the water column.
- 4.4 Carefully raise the bailer.
 - 4.4.1 Retrieve the bailer at the same rate of 2 cm/sec until the bottom of the bailer has cleared to top of the water column.

- 4.5 Measure the purge volume by one of the methods outlined in FS 2212, section 1.
 - 4.5.1 Record the volume of the bailer.
- 4.6 Continue to carefully lower and retrieve the bailer as described above until the purging completion conditions specified in FS 2212, section 3, have been satisfied.
 - 4.6.1 Remove at least one (1) well volume before collecting measurements of the field parameters. Take each subsequent set of measurements after removing at least one quarter (1/4) well volume between measurements.

FS 2214 *Purging Large-Volume, High-Recharge Wells With Portable Pumps*

If a well originally constructed for high-flow-rate pumping will be sampled as a monitoring well, use these guidelines to develop a purging procedure applicable to the specific details of the well construction. Typical wells constructed for this purpose may be deep, large-diameter wells with a section of open borehole. Evaluate each well on a case-by-case basis and consider any available information on the construction and hydraulic performance of the well.

1. PURGING PROCEDURE

- 1.1 Place the pump at the top of the open borehole segment of the well.
- 1.2 Start purging while monitoring stabilization parameters as in FS 2212, section 3 above.
- 1.3 Purge at least one equipment volume before measuring stabilization parameters.
- 1.4 If the well is being purged for the first time using these guidelines, monitor stabilization parameters for an extended period until confident that sufficient volume has been pumped from the open borehole to draw fresh formation water into the pump tubing and flow-through container. Use the information obtained from the first-time purging of the well to determine the pumping rate and duration of purging required for future sampling events at the well.
- 1.5 Purge at least three equipment volumes before evaluating purging completion.

2. PURGING COMPLETION

- 2.1 Complete the purging of the well when the last three consecutive measurements of the purge stabilization parameters have met the applicable criteria specified in FS 2212, section 3 above.

3. Collect samples from the well using the procedures in FS 2221, section 1 below.

FS 2215. *Purging Wells With Plumbing (production wells or permanently installed pumps equipped with sampling ports or sampling spigots)*

Wells with in-place plumbing are commonly found at municipal water treatment plants, industrial water supplies, private residences, etc. Depending on the sampling objective for collecting samples using installed plumbing, purge the system and collect samples closest to the point of consumption, or, as close to the source well as possible. When purging is required and the purge volume of the plumbing system is not known, purge the system until the purging completion criteria in FS 2212, section 3, have been met.

1. CONTINUOUSLY RUNNING PUMPS

- 1.1 Select the spigot that is closest to the pump and before any storage tanks (if possible).
- 1.2 Remove all hoses, aerators and filters (if possible).
- 1.3 Open the spigot and purge at maximum flow.

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1.4 If a storage tank is located between the pump and the spigot, purge the volume of the tank, lines and spigot.

1.5 If the spigot is before any storage tank, purge until sufficient volume is removed to flush the stagnant water from the spigot and the tap line to the spigot.

1.6 Reduce the flow rate to ≤ 500 mL/minute (a 1/8" stream) or approximately 0.1 gal/minute before collecting samples. When sampling for volatile organic compounds, reduce the flow to ≤ 100 mL/minute before collecting the samples.

2. INTERMITTENTLY RUNNING PUMPS

2.1 Select the spigot that is closest to the pump and before any storage tanks (if possible).

2.2 Remove all hoses, aerators and filters (if possible).

2.3 Open the spigot and purge sufficient volume at a maximum, practical flow rate to flush the spigot and lines and until the purging completion criteria in FS 2212, section 3, have been met.

2.4 If a storage tank is located between the pump and the spigot, purge the volume of the tank, lines and spigot.

2.5 Ensure that the purge stabilization measurement of dissolved oxygen is not biased with aeration of the sample by a high flow rate in the flow-through container.

2.6 Reduce the flow rate to ≤ 500 mL/minute (a 1/8" stream) or approximately 0.1 gal/minute before collecting samples. When sampling for volatile organic compounds, reduce the flow to ≤ 100 mL/minute before collecting the samples.

FS 2216. *Purging Airstrippers and Remedial Treatment Systems*

If collecting samples for groundwater contamination monitoring, follow FS 2215 above.

FS 2220. GROUNDWATER SAMPLING TECHNIQUES

1. Purge wells using the techniques outlined in FS 2210.

2. Replace the protective covering around the well if it is soiled or torn after completing the purging operations.

3. GENERAL CONSIDERATIONS FOR SAMPLING EQUIPMENT AND PROCEDURES

Follow all notes and restrictions as indicated in Table FS 2200-1 and as discussed in FS 2201.

NOTE: The only pumps that are currently approved for use in collecting samples for the analysis of volatile organic compounds (VOCs) through the pump without additional restrictions are stainless steel and Teflon variable speed submersible pumps; stainless steel and Teflon or Polyethylene variable speed bladder pumps; and, permanently installed variable speed bladder or submersible pumps with PVC bodies, as long as the PVC pump remains in contact with the water in the well at all times. Peristaltic pumps may be used for VOC sample collection only according to the requirements in this SOP.

3.1 Collect the sample into the sample container to be sent to the laboratory directly from the sampling tap or spigot, the pump delivery tubing or other sampling device. **Do not** use intermediate containers.

3.2 In order to avoid contaminating the sample or loss of analytes from the sample:

3.2.1 Handle the sampling equipment as little as possible.

3.2.2 Minimize the amount of equipment that is exposed to the sample, where possible.

3.2.3 Employ precautions and procedures specific to the collection of samples for VOC analysis.

3.2.3.1 Minimize aeration of samples collected for VOC analysis.

3.2.3.2 Reduce flow rates to 100 - 400 mL/minute when using a pump to collect VOC samples. Attempt to maximize the flow rate within this range. Do not sample at flow rates lower than 100 mL/minute or higher than 400 mL/minute.

3.2.3.3 See subpart FS 2221, section 1, including subsections 1.1 – 1.1.3.9, 1.2 – 1.2.3.3, 1.3.2 – 1.3.3.1, 1.3.4 – 1.3.4.2 and 1.4 for additional VOC sampling instructions, restrictions, precautions and criteria.

3.3 Dedicated Sampling Equipment

3.3.1 Whenever possible, use dedicated equipment because it significantly reduces the chance of cross-contamination.

3.3.2 Dedicated is defined as equipment that is to be used solely for one location for the life of that equipment (e.g., permanently mounted pump).

3.3.3 All material construction and restrictions from Table FS 2200-1 also apply to dedicated equipment. Purchase equipment with the most sensitive analyte of interest in mind.

3.4 Cleaning/Decontamination

3.4.1 Clean or ensure dedicated pumps are clean before installation. They do not need to be cleaned prior to each use but must be cleaned if they are withdrawn for repair or servicing.

3.4.2 Clean or make sure any permanently mounted tubing is clean before installation.

3.4.3 Change or clean tubing when the pump is withdrawn for servicing.

3.4.4 Clean any replaceable or temporary parts as specified in FC 1000.

3.4.5 Collect equipment blanks on dedicated pumping systems when the tubing is cleaned or replaced.

3.4.6 Clean or ensure dedicated bailers are clean before placing them into the well.

3.4.7 Collect an equipment blank on dedicated bailers before introducing them into the water column.

3.4.8 Suspend dedicated bailers above the water column if they are stored in the well.

FS 2221. *Sampling Wells Without Plumbing*

1. **SAMPLING WITH PUMPS:** Variable speed stainless steel and Teflon submersible pumps; stainless steel, Teflon or Polyethylene bladder pumps; and, permanently installed variable speed submersible or bladder pumps with PVC bodies (as long as the pump remains in contact with the water in the well at all times), may be used to sample for all organics. The pump tubing must be Teflon, polyethylene or polypropylene. Do not use low-density polyethylene (LDPE) bladders or tubing to collect samples for volatile organic compounds (VOCs). **Extractable organics** may be collected through a peristaltic pump if ≤ 1 foot of silicone tubing is used in the pump head or a vacuum trap is used (see Figure FS 2200-1 for specific configuration). Samples for **volatile organic compounds** (VOCs) may be collected through the peristaltic pump roller tubing if ≤ 1 foot of silicone tubing is used in the pump roller head, according to the instructions and restrictions listed in section 1.1.1, below. Follow all notes and restrictions as defined in Table FS 2200-1 and discussed in Equipment and Supplies (FS 2201) when using pumps to collect samples. Do not lower the pump or tubing to the bottom of the well.

1.1 Peristaltic Pump

1.1.1 Volatile Organics Collected Through the Pump Roller Tubing: Ensure that no more than a maximum length of one foot of new silicone tubing is installed in the peristaltic pump roller head assembly before the well is purged, if the same pump and tubing assembly is used to purge and sample the well. Otherwise, install a new length of silicone roller tubing as described above before beginning to sample (see NOTE below). If the pump will be used to sample more than one well, replace the silicone roller tubing before purging and sampling each new well. Use Teflon, Kynar, high-density polyethylene (HDPE) or similarly inert material for the drop (down-hole) and delivery tubing. Do not use low-density polyethylene (LDPE) tubing. Minimize aeration of the sample during collection. If samples for additional analytes other than VOCs will be collected, fill the VOC sample containers last, if possible. For low-recharge wells, collect VOCs first after purging is completed, where excessive drawdown or dry purging occurs. **NOTE:** Depending on the recharge characteristics of the well and sampler skill, attempt to maximize the flow rate for VOC sample collection within the range stipulated below in sections 1.1.1.1 and 1.1.1.2. Collect the VOC sample directly into the sample container from the discharge flow exiting from the pump delivery tubing. Disconnect flow-through containers, manifolds, valves or other devices from the delivery tubing before collecting the VOC samples, if applicable. If the tubing assembly intended for VOC sample collection was not used to purge the well, begin pumping using the new sampling tubing assembly, adjust the pumping rate for the maximum possible flow rate for VOC sampling and pump a minimum of 3 equipment volumes (pump and tubing volume) through the entire tubing assembly before collecting the VOC samples. If the pump tubing is placed within the screened interval, new tubing cannot be reinserted into the well and the same tubing must be used for purging and sampling.

1.1.1.1 For wells with sufficient recharge where the pumping rate can be matched with the recharge rate, use tubing with the smallest practical inside diameter and collect VOC samples with a pumping rate in the range of 100 mL/minute – 400 mL/minute. Attempt to maximize the flow rate within this range. Do not reduce the flow rate below 100 mL/minute or exceed 400 mL/minute while sampling. Minimize aeration of the sample during collection, and observe all other precautions as indicated in FS 2000, subpart FS 2004. If samples for additional analytes other than VOCs will be collected, fill the VOC sample containers last, if possible.

1.1.1.2 For low-recharge wells, use tubing with the smallest practical inside diameter and collect VOC samples with a pumping rate in the range of 100 mL/minute – 400 mL/minute. Attempt to maximize the flow rate within this range. Do not reduce the flow rate below 100 mL/minute (if possible) or exceed 400 mL/minute while sampling. Minimize aeration of the sample during collection, and observe all other precautions as indicated in FS 2000, subpart FS 2004. If samples for additional analytes other than VOCs will be collected, fill the VOC sample containers last, if possible. Collect VOCs first after purging is completed, where excessive drawdown or dry purging occurs. See subpart FS 2212, section 3.7 for wells that purge dry.

1.1.2 Volatile Organics Using Manual Fill and Drain Method: This method is also denoted as the “straw” method (with gravity drain). Collect volatile organics last. If the pump tubing is placed within the screened interval, do not reinsert the tubing into the well after withdrawing, and do not repeat steps 1.1.2.3 through 1.1.2.6.

1.1.2.1 Insert sufficient length of drop tubing to provide enough sample volume to fill all necessary VOC sample containers, if possible.

- 1.1.2.2 Remove the drop tubing from the inlet side of the pump.
- 1.1.2.3 Submerge the drop tubing into the water column and allow it fill.
- 1.1.2.4 Remove the drop tubing from the well.
- 1.1.2.5 Prevent the water in the tubing from flowing back into the well.
- 1.1.2.6 Carefully allow the groundwater to drain by gravity into the VOC sample containers. Avoid turbulence. Do not aerate the sample.
- 1.1.2.7 Repeat steps 1.1.2.3 - 1.1.2.6 until enough sample containers are filled.
- 1.1.3 Volatile Organics Using the Pump to Fill and Drain the Tubing: This method is also denoted as the “straw” method with reverse-flow. Collect volatile organics last. If the pump tubing is placed within the screened interval, do not reinsert the tubing into the well after withdrawing, and do not repeat steps 1.1.3.2 through 1.1.3.8, below. Do not reduce the flow rate below 100 mL/minute or exceed 400 mL/minute while pumping. Do not collect sample that has passed through the pump roller head silicone tubing.
 - 1.1.3.1 Insert sufficient length of drop tubing to provide enough sample volume to fill all necessary VOC sample containers, if possible.
 - 1.1.3.2 Submerge the drop tubing into the water column.
 - 1.1.3.3 Use the pump to fill the drop tubing.
 - 1.1.3.4 Quickly remove the tubing from inlet side of the pump.
 - 1.1.3.5 Prevent the water in the tubing from flowing back into the well.
 - 1.1.3.6 Remove the drop tubing from the well and fill the VOC sample containers using the reverse-flow or gravity-drain methods in steps 1.1.3.7 or 1.1.3.8 below.
 - 1.1.3.7 Reverse the flow on the peristaltic pump to deliver the sample into the VOC sample containers at a slow, steady rate. Avoid turbulence. Do not aerate the sample.
 - 1.1.3.8 Or, remove the drop tubing from the inlet side of the pump and carefully allow the groundwater to drain into the VOC sample containers. Avoid turbulence. Do not aerate the sample.
 - 1.1.3.9 Repeat steps 1.1.3.2 - 1.1.3.8 until enough VOC sample containers are filled.
- 1.1.4 Extractable Organics Collected Through Silicone Pump-Head Tubing:
 - 1.1.4.1 Ensure that a 1-foot maximum length of new silicone tubing was installed in the peristaltic pump head assembly before the well was purged if the same pump is being used to purge and sample the well. Otherwise, install a new length of tubing as described above.
 - 1.1.4.2 Collect extractable organic samples directly from the effluent delivery tubing (attached to discharge side of the silicone pump head tubing) into the sample container.
 - 1.1.4.3 If there is a concern that sample analytes are absorbed, adsorbed, leached or otherwise affected or lost by pumping through the silicone pump-head tubing, sample the well using the organic trap assembly in 1.1.4 below.
- 1.1.5 Extractable Organics Using an Optional Organic Trap Assembly
 - 1.1.5.1 Assemble the components of the pump and trap according to Figure FS 2200-1.
 - 1.1.5.2 The sample container should be the trap bottle.

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1.1.5.3 All equipment that contacts the groundwater **before** the sample container must be constructed of Teflon, Polyethylene, Polypropylene, stainless steel or glass, including the transport tubing to and from the sample container, the interior liner of the container cap and all fittings. **Do not use a rubber stopper as a cap.**

1.1.5.4 Connect the outflow tubing from the container to the influent side of the peristaltic pump.

1.1.5.5 Prevent the water in the down-hole delivery tubing from flowing back into the well while performing this connection.

1.1.5.6 Turn the pump on and reduce the flow rate to a smooth and even flow.

1.1.5.7 Discard a small portion of the sample to allow an air space.

1.1.5.8 Preserve (if required), label and complete the field notes.

1.1.6 Inorganics

1.1.6.1 Inorganic samples may be collected from the effluent tubing.

1.1.6.2 If samples are collected from the pump, decontaminate all tubing (including the tubing in the head) or change it between wells.

1.1.6.3 Preserve (if required), label and complete field notes.

1.2 Variable Speed Bladder Pump

1.2.1 If sampling for organics the pump body must be constructed of stainless steel and the valves and bladder must be Teflon, polyethylene or polypropylene. All tubing must be Teflon, Polyethylene, or Polypropylene and any cabling must be sealed in Teflon, Polyethylene or Polypropylene, or made of stainless steel. Do not use low-density polyethylene (LDPE) tubing or bladders for the collection of VOC samples.

1.2.2 After purging to a smooth even flow, reduce the flow rate.

1.2.2.1 When sampling for volatile organic compounds, reduce the flow rate to 100 – 400 mL/minute, if possible. Attempt to maximize the flow rate within this range.

1.2.3 Sampling for Volatile Organic Compounds (VOCs)

1.2.3.1 Use Teflon, Kynar, HDPE or similarly inert material for the bladder or tubing. Do not use LDPE bladders or tubing. Minimize aeration of the sample during collection. If samples for additional analytes other than VOCs will be collected, fill the VOC sample containers last, if possible. For low-recharge wells, collect VOCs first after purging is completed, where excessive drawdown or dry purging occurs. Depending on the recharge characteristics of the well and sampler skill, attempt to maximize the flow rate for VOC sample collection within the range stipulated above in section 1.2.3. Collect the VOC sample directly into the sample container from the discharge flow exiting from the pump delivery tubing. Disconnect flow-through containers, manifolds, valves or other devices from the delivery tubing before collecting the VOC samples, if applicable.

1.2.3.2 If the pump and/or tubing assembly intended for VOC sample collection was not used to purge the well, begin pumping using the sampling pump and/or tubing assembly, adjust the pumping rate for the maximum possible flow rate for VOC sampling and pump a minimum of 3 equipment volumes (pump and tubing volume) through the entire tubing assembly before collecting the VOC samples.

1.2.3.3 If the pump is placed within the screened interval, use the same pump and tubing assembly for both purging and sampling.

1.3 Variable Speed Submersible Pump

1.3.1 The housing must be stainless steel.

1.3.2 If sampling for organics, the internal impellers, seals and gaskets must be constructed of stainless steel, Teflon, Polyethylene or Polypropylene. The delivery tubing must be Teflon, Polyethylene or Polypropylene. Do not use low-density polyethylene (LDPE) for the collection of VOC samples. The electrical cord must be sealed in Teflon, Polyethylene or Polypropylene, and any cabling must be sealed in Teflon, Polyethylene or Polypropylene, or constructed of stainless steel.

1.3.3 After purging to a smooth even flow, reduce the flow rate.

1.3.3.1 When sampling for volatile organic compounds, reduce the flow rate to 100 – 400 mL/minute, if possible. Attempt to maximize the flow rate within this range.

1.3.4 Sampling for Volatile Organic Compounds (VOCs)

1.3.4.1 Use Teflon, Kynar, HDPE or similarly inert material for the pump tubing. Do not use LDPE tubing. Minimize aeration of the sample during collection. If samples for additional analytes other than VOCs will be collected, fill the VOC sample containers last, if possible. For low-recharge wells, collect VOCs first after purging is completed, where excessive drawdown or dry purging occurs. Depending on the recharge characteristics of the well and sampler skill, attempt to maximize the flow rate for VOC sample collection within the range stipulated above in section 1.3.4. Collect the VOC sample directly into the sample container from the discharge flow exiting from the pump delivery tubing. Disconnect flow-through containers, manifolds, valves or other devices from the delivery tubing before collecting the VOC samples, if applicable.

1.3.4.2 If the pump and/or tubing assembly intended for VOC sample collection was not used to purge the well, begin pumping using the sampling pump and/or tubing assembly, adjust the pumping rate for the maximum possible flow rate for VOC sampling and pump a minimum of 3 equipment volumes (pump and tubing volume) through the entire tubing assembly before collecting the VOC samples.

1.4 For all analytes, if the pump is placed within the screened interval, use the same pump and tubing assembly for both purging and sampling.

2. SAMPLING WITH BAILERS: A high degree of skill and coordination are necessary to collect representative samples with a bailer. When properly used, bailers may be used to collect samples for certain analyte groups and under specific conditions (see Table FS 2200-3). They must be of an appropriate type and construction (see FS 2201, section 3), and must be used as outlined below. If in doubt about the appropriateness of using a bailer at a site or during a particular sampling event, contact the appropriate DEP program or project manager.

2.1 General Considerations

2.1.1 Minimize handling the bailer as much as possible.

2.1.1.1 Wear sampling gloves.

2.1.1.2 Remove the bailer from its protective wrapping just before use.

2.1.1.3 Attach a lanyard of appropriate material (see FS 2201, section 4).

2.1.1.4 Use the lanyard to move and position the bailers.

2.1.2 Do not allow the bailer or lanyard to touch the ground.

2.1.3 Rinsing

2.1.3.1 If the bailer is certified precleaned, no rinsing is necessary.

2.1.3.2 If both a pump and a bailer are to be used to collect samples, rinse the exterior and interior of the bailer with sample water from the pump before removing the pump.

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2.1.3.3 If the purge pump is not appropriate for collecting samples (e.g., non-inert components), rinse the bailer with by collecting a single bailer of the groundwater to be sampled. Use the technique described in section 2.2, Bailing Technique, below.

2.1.3.4 Discard the water appropriately.

2.1.3.5 **Do not** rinse the bailer if Oil & Grease, TRPHs, etc., (see FS 2006) are to be collected.

2.2 Bailing Technique

2.2.1 Collect all samples that are required to be collected with a pump before collecting samples with the bailer.

2.2.2 Raise and lower the bailer gently to minimize stirring up particulate matter in the well and the water column which can increase sample turbidity.

2.2.3 Lower the bailer carefully into the well to a depth approximately a foot above the water column. Ensure that the length of the bailer does not exceed the length of the water column.

2.2.3.1 When the bailer is in position, lower the bailer into the water column at a rate of 2 cm/sec until the desired depth is reached (see section 2.2.3 above).

2.2.4 Do not lower the top of the bailer more than one (1) foot below the top of the water table so that water is removed from the top of the water column.

2.2.5 Allow time for the bailer to fill with aquifer water as it descends into the water column.

2.2.6 Do not allow the bailer to touch the bottom of the well or particulate matter will be incorporated into the sample.

2.2.6.1 Carefully raise the bailer (see section 2.2.2 above). Retrieve the bailer at the same rate of 2 cm/sec until the bottom of the bailer has cleared to top of the water column.

2.2.7 Lower the bailer to approximately the same depth each time.

2.2.8 Collect the sample.

2.2.8.1 Install a device to control the flow from the bottom of the bailer and discard the first few inches of water. Reduce the flow to ≤ 100 mL/minute when collecting VOC samples.

2.2.8.2 Fill the appropriate sample containers by allowing the sample to slowly flow down the side of the container. Minimize aeration of VOC samples.

2.2.8.3 Discard the last few inches of water in the bailer.

2.2.9 Repeat steps 2.2.1 through 2.2.8.3 for additional samples.

2.2.10 Measure the DO, pH, temperature, turbidity and specific conductance after the final sample has been collected.

2.2.10.1 Record all measurements and note the time that sampling was completed.

3. SAMPLING WELLS WITH FLOATING NON-AQUEOUS PHASE LIQUID: DEP does not recommend the sampling of wells with floating non-aqueous phase liquid for trace contaminants. This concerns primarily petroleum related sites, but includes any chemical product (e.g., solvent) that floats on the water table. Sampling is acceptable if the information is to be used for the purpose of remedial design.

Sample data from such wells cannot provide useful information regarding the level of contamination. Furthermore, these wells typically do not provide legitimate data because of

permanent chemical contamination from product contact with the well casing for an extended period of time.

DEP does reserve the right to require sampling of these wells, not for levels of trace contaminants, but for confirmation of an appropriate remediation technique. This type of sampling is performed **below** the non-aqueous phase layer (see section 3.2 below).

3.1 Non-Aqueous Phase Liquid Sampling: Non-aqueous phase liquid may be evident in a cased monitoring well or in an open excavation.

3.1.1 Non-aqueous phase liquid is normally sampled for two reasons:

- Documentation for its existence and thickness; and
- Determination of the type of product so that the proper analyses can be performed to determine extent. This is only feasible for relatively recent releases as it may not be possible to identify weathered product.

3.1.2 Disposable plastic (acrylic, clear PVC) bailers are recommended for sampling. Disposable Polyethylene and Polypropylene bailers are also acceptable. Other wide mouth vessels may be used for sampling non-aqueous phase liquid in an excavation.

3.1.3 Monitoring Well

3.1.3.1 If a non-aqueous phase liquid is identified in a monitoring well during the water level measurement, measure its thickness in the well. If the thickness of the non-aqueous phase liquid is greater than 0.01 foot or product globules are present, collect a sample using a precleaned disposable bailer.

3.1.3.2 Measure the product thickness to the nearest 0.01 foot after withdrawing the bailer.

3.1.3.3 Pour a portion of the product into a glass sample container.

3.1.3.4 This sample is considered a concentrated waste. Therefore, package the container in protective wrapping to prevent breakage, isolate from other samples, and ice to 4°C.

3.1.4 Excavation

3.1.4.1 If non-aqueous phase liquid is observed in an open excavation, a glass sample container or a precleaned intermediate vessel may be used to collect the sample.

3.1.4.2 Securely tie a lanyard to the container and lower it into the excavation.

3.1.4.3 Gently lower and retrieve the container so that no solid material is released or collected.

3.1.4.4 If sufficient water is available, a bailer can be used.

3.1.4.5 Although not recommended, screened casing can be placed (or augered and placed) in the bottom of the excavation and the product sampled with a bailer.

3.1.4.6 Avoid dangerous situations, such as standing too close to the edge of an excavation, riding in the backhoe bucket, or entering a trench or excavation that may collapse.

3.1.4.7 DEP recommends following all applicable OSHA regulations.

3.2 Sampling Below Product

3.2.1 This type of depth-specific sampling to attempt to sample the dissolved constituents in the water column below the product layer is performed only at the request of DEP or its designee.

3.2.2 These data provide information that helps define adequate groundwater treatment. Without these data, incorrect (and sometimes unnecessarily expensive) remediation techniques may be designed for a situation where they are not required.

3.2.3 There are some substantial logistical problems involved with sending a sampler through non-aqueous phase liquid to sample the groundwater below. Although there are some products designed specifically for this type of sampling, they are expensive and the results may not be commensurate with their cost. The use of "self-engineered" equipment or coverings may be the best option.

3.2.4 These data are only to be used for qualitative use and will aid in deciding on an appropriate remediation technique.

3.2.5 Wrapping bailers and tubing in plastic seems to be the most popular technique in getting past the product layer.

3.2.6 Although not recommended, some have wrapped submersible pumps in several layers of plastic and retrieved each layer by a separate lanyard. One suggestion would be to use a rigid piece of stainless steel tubing wrapped in plastic.

3.2.6.1 Once the covered tubing is past the layer, pull up on the plastic, piercing the plastic and exposing the (somewhat) clean tubing inlet.

3.2.6.2 Introduce the wrapped hose slowly to not entrain any more product into the dissolved layer located below.

3.2.6.3 Also, perform this procedure with a peristaltic pump or a vacuum pump linked to a trap bottle. To use this setup, the water table must be no deeper than 15-20 feet, realizing that actual sampling may be occurring several feet below the product layer.

FS 2222. *Sampling Low Permeability Aquifers or Wells That Have Purged Dry*

1. Collect the sample(s) after the well has been purged according to FS 2212, section 3.4. Minimize the amount of water removed from the well by using the same pump to purge and collect the sample. If the well has purged dry, collect samples as soon as sufficient sample water is available. If samples for additional analytes other than VOCs will be collected, fill the VOC sample containers last, if possible. However, collect VOCs first after purging is completed, where excessive drawdown or dry purging occurs.
2. Measure the five (5) field parameters Temperature, pH, Specific Conductance, Dissolved Oxygen and Turbidity at the time of sample collection.
3. Advise the analytical laboratory and the client that the usual amount of sample for analysis may not be available.

FS 2223. *Sampling Wells With In-Place Plumbing*

1. If a storage tank is present, locate a cold water spigot, valve or other sampling point close to the well head between the pump and the storage tank. If there is no sampling location between the pump and the storage tank, locate the spigot, valve or other sampling point closest to the tank.
 - 1.1 Depending on the sampling objective for collecting samples using installed plumbing, purge the system and collect samples closest to the point of consumption, or, as close to the source well as possible.
2. Remove all screens or aerators and reduce the flow rate to no more than 500 mL/minute. If collecting samples for volatile organic compounds, reduce the flow rate to 100 mL/minute or less. Collect the samples directly into the appropriate containers.

FS 2224. *Sampling Airstripper and Remedial Treatment System Sampling*

1. Reduce the flow rate to less than 500 mL/minute and begin sample collection.
2. If collecting samples for volatile organic compounds, reduce the flow rate to 100 mL/minute or less.
3. Collect the samples directly into the appropriate containers.

FS 2225. *Filtering Groundwater Samples*

Filtered groundwater samples can only be collected after approval from the DEP program or project manager. If filtering is approved, the DEP program or permit condition may require both filtered and unfiltered samples to be collected, analyzed and reported.

1. FILTERING GROUNDWATER FOR METALS:
 - 1.1 Unless specified otherwise by the DEP program, use a new, disposable, high capacity, 1- μ m in-line filter.
 - 1.2 Use a variable speed peristaltic, bladder or submersible pump with the in-line filter fitted on the outlet end.
 - 1.2.1 Peristaltic pumps, bladder pumps or submersible pumps can be used when water levels are no greater than 20 to 25 feet deep.
 - 1.2.2 Bladder pumps or submersible pumps must be used when water levels are greater than 20 to 25 feet deep.
 - 1.3 Ensure that a 1-foot maximum length of new, silicone tubing was installed in the peristaltic pump head assembly before the well was purged if the same pump is being used to purge and sample the well. Otherwise, install a new length of tubing as described above.
 - 1.4 Ensure that new or precleaned delivery tubing was assembled with the peristaltic pump before the well was purged if the same pump is being used to purge and sample the well. Otherwise, assemble the pump with new or precleaned delivery tubing and the new filter.
 - 1.5 Insert the filter on the high pressure side (i.e., on the delivery side) of the pump.
 - 1.5.1 Flush the filter before attaching to the pump tubing assembly with 30-50 mL of analyte free water or an inert gas (nitrogen) to remove atmospheric oxygen;
 - 1.5.2 Or, with the filter attached to the pump tubing assembly, hold the filter upright with the inlet and outlet in the vertical position and pump water from the aquifer through the filter until all atmospheric oxygen has been removed.
 - 1.6 Collect the filtered samples directly into the sample container from the high-pressure (delivery) side of the pump tubing assembly.
 - 1.6.1 Collect filtered samples by either of the methods in 1.6.1.3 or 1.6.1.4 below if the static water level in the well is too deep for a variable speed peristaltic pump and a variable speed electric submersible pump or variable speed bladder pump is not available.
 - 1.6.1.1 Do not agitate the sample or expose it to atmospheric oxygen.
 - 1.6.1.2 **Do not** pour the sample into any intermediate vessel for subsequent filtration.
 - 1.6.1.3 Collect the sample in a Polyethylene, Teflon or Polypropylene bailer that can be pressurized. When the bailer has been retrieved, immediately connect the filter and begin to pressurize the bailer;

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1.6.1.4 Or, collect the sample with a bailer and immediately place the intake tube of the peristaltic pump into the full bailer and begin pumping the water through the filter as described in section 1.2 above.

1.7 **Do not** use the following equipment for filtering groundwater samples for metals:

1.7.1 Any pump and apparatus combination in which the filter is on the vacuum (suction) side of the pump.

1.7.2 Any type of syringe or barrel filtration apparatus.

1.7.3 Any filter that is not encased in a one-piece, molded unit.

2. Filtering groundwater for non-metallic analytes

2.1 The following analytes cannot be filtered:

- Oil and Grease
- Total Recoverable Petroleum Hydrocarbons (TRPH)
- FL-PRO
- Volatile Organic Compounds (VOC)
- Microbiological Analytes
- Volatile Inorganic Compounds (e.g., Hydrogen Sulfide)

2.2 Unless specified otherwise by the regulatory program, use a new, disposable, high capacity, 0.45 μm in-line filter.

2.3 Assemble the pump, tubing and filter as in 1.2 – 1.5 above.

2.4 Flush the filter as in 1.5.1 or 1.5.2 above.

2.5 Collect the samples as in 1.6 – 1.6.1.4 above.

Appendix FS 2200
Tables, Figures and Forms

Table FS 2200-1 Equipment for Collecting Groundwater Samples

Table FS 2200-2 Dissolved Oxygen Saturation

Table FS 2200-3 Allowable Uses for Bailers

Figure FS 2200-1 Pump and Trap for Extractable Organics

Figure FS 2200-2 Groundwater Purging Procedures

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FS 2200 Groundwater Sampling

Table FS 2200-1
Equipment for Collecting Groundwater Samples

Activity	Equipment Type
Well Purging	Variable speed centrifugal pump Variable speed submersible pump Variable speed bladder pump Variable speed peristaltic pump Bailer with lanyard: Not Recommended
Well Stabilization	pH meter DO meter Conductivity meter Thermometer/Thermistor Turbidimeter Flow-through cell Multi-function meters
Sample Collection	Variable speed peristaltic pump Variable speed submersible pump Variable speed bladder pump Bailer with lanyard (See Table FS 2200-3)
Filtration	Variable speed peristaltic pump Variable speed submersible pump Variable speed bladder pump Pressurized bailer 1.0 µm high capacity molded filter 0.45 µm high capacity molded filter
Groundwater Level	Electronic sensor Chalked tape

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FS 2200 Groundwater Sampling

Table FS 2200-2
Dissolved Oxygen Saturation

TEMP	D.O.	mg/L	TEMP	D.O.	mg/L	TEMP	D.O.	mg/L	TEMP	D.O.	mg/L
deg C	SAT.	20%	deg C	SAT.	20%	deg C	SAT.	20%	deg C	SAT.	20%
15.0	10.084	2.017	19.0	9.276	1.855	23.0	8.578	1.716	27.0	7.968	1.594
15.1	10.062	2.012	19.1	9.258	1.852	23.1	8.562	1.712	27.1	7.954	1.591
15.2	10.040	2.008	19.2	9.239	1.848	23.2	8.546	1.709	27.2	7.940	1.588
15.3	10.019	2.004	19.3	9.220	1.844	23.3	8.530	1.706	27.3	7.926	1.585
15.4	9.997	1.999	19.4	9.202	1.840	23.4	8.514	1.703	27.4	7.912	1.582
15.5	9.976	1.995	19.5	9.184	1.837	23.5	8.498	1.700	27.5	7.898	1.580
15.6	9.955	1.991	19.6	9.165	1.833	23.6	8.482	1.696	27.6	7.884	1.577
15.7	9.934	1.987	19.7	9.147	1.829	23.7	8.466	1.693	27.7	7.870	1.574
15.8	9.912	1.982	19.8	9.129	1.826	23.8	8.450	1.690	27.8	7.856	1.571
15.9	9.891	1.978	19.9	9.111	1.822	23.9	8.434	1.687	27.9	7.842	1.568
16.0	9.870	1.974	20.0	9.092	1.818	24.0	8.418	1.684	28.0	7.828	1.566
16.1	9.849	1.970	20.1	9.074	1.815	24.1	8.403	1.681	28.1	7.814	1.563
16.2	9.829	1.966	20.2	9.056	1.811	24.2	8.387	1.677	28.2	7.800	1.560
16.3	9.808	1.962	20.3	9.039	1.808	24.3	8.371	1.674	28.3	7.786	1.557
16.4	9.787	1.957	20.4	9.021	1.804	24.4	8.356	1.671	28.4	7.773	1.555
16.5	9.767	1.953	20.5	9.003	1.801	24.5	8.340	1.668	28.5	7.759	1.552
16.6	9.746	1.949	20.6	8.985	1.797	24.6	8.325	1.665	28.6	7.745	1.549
16.7	9.726	1.945	20.7	8.968	1.794	24.7	8.309	1.662	28.7	7.732	1.546
16.8	9.705	1.941	20.8	8.950	1.790	24.8	8.294	1.659	28.8	7.718	1.544
16.9	9.685	1.937	20.9	8.932	1.786	24.9	8.279	1.656	28.9	7.705	1.541
17.0	9.665	1.933	21.0	8.915	1.783	25.0	8.263	1.653	29.0	7.691	1.538
17.1	9.645	1.929	21.1	8.898	1.780	25.1	8.248	1.650	29.1	7.678	1.536
17.2	9.625	1.925	21.2	8.880	1.776	25.2	8.233	1.647	29.2	7.664	1.533
17.3	9.605	1.921	21.3	8.863	1.773	25.3	8.218	1.644	29.3	7.651	1.530
17.4	9.585	1.917	21.4	8.846	1.769	25.4	8.203	1.641	29.4	7.638	1.528
17.5	9.565	1.913	21.5	8.829	1.766	25.5	8.188	1.638	29.5	7.625	1.525
17.6	9.545	1.909	21.6	8.812	1.762	25.6	8.173	1.635	29.6	7.611	1.522
17.7	9.526	1.905	21.7	8.794	1.759	25.7	8.158	1.632	29.7	7.598	1.520
17.8	9.506	1.901	21.8	8.777	1.755	25.8	8.143	1.629	29.8	7.585	1.517
17.9	9.486	1.897	21.9	8.761	1.752	25.9	8.128	1.626	29.9	7.572	1.514
18.0	9.467	1.893	22.0	8.744	1.749	26.0	8.114	1.623	30.0	7.559	1.512
18.1	9.448	1.890	22.1	8.727	1.745	26.1	8.099	1.620	30.1	7.546	1.509
18.2	9.428	1.886	22.2	8.710	1.742	26.2	8.084	1.617	30.2	7.533	1.507
18.3	9.409	1.882	22.3	8.693	1.739	26.3	8.070	1.614	30.3	7.520	1.504
18.4	9.390	1.878	22.4	8.677	1.735	26.4	8.055	1.611	30.4	7.507	1.501
18.5	9.371	1.874	22.5	8.660	1.732	26.5	8.040	1.608	30.5	7.494	1.499
18.6	9.352	1.870	22.6	8.644	1.729	26.6	8.026	1.605	30.6	7.481	1.496
18.7	9.333	1.867	22.7	8.627	1.725	26.7	8.012	1.602	30.7	7.468	1.494
18.8	9.314	1.863	22.8	8.611	1.722	26.8	7.997	1.599	30.8	7.456	1.491
18.9	9.295	1.859	22.9	8.595	1.719	26.9	7.983	1.597	30.9	7.443	1.489

Derived using the formula in Standard Methods for the Examination of Water and Wastewater, Page 4-101, 18th Edition, 1992

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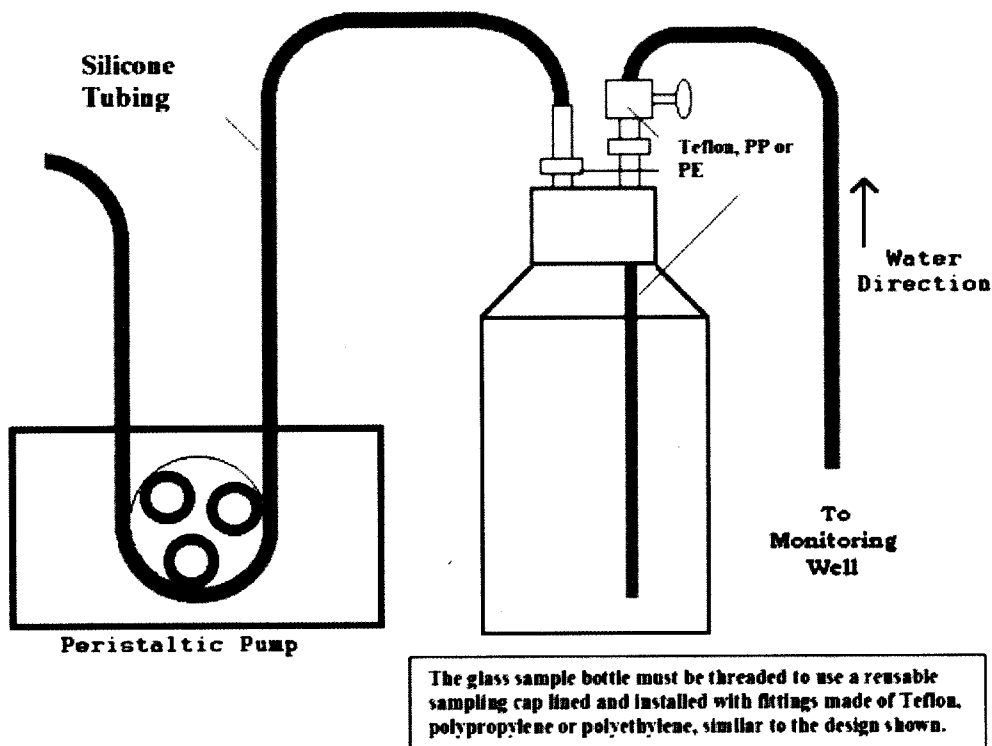
**Table FS 2200-3
Allowable Uses for Bailers**

• ANALYTE GROUP(S)	• PURGING (Not Recommended)	• SAMPLING	
	Use:	Use:	Not Recommended:
Volatile Organics Extractable Organics Radionuclides, including Radon Metals Volatile Sulfides	If allowed by permit, program, contract or order or If operated by a skilled individual with documented training in proper techniques. Field documentation must demonstrate that the procedure in FS 2213, section 4 was followed without deviation.	If concentrations exceed action levels, the purpose is to monitor effective treatment, and the DEP program allows the use of bailers; or If specified by DEP permit, program, contract or order. or If operated by a skilled individual with documented training in proper techniques and using appropriate equipment. Field documentation must demonstrate that the procedure in FS 2221, section 2 was followed without deviation.	If concentrations are near or below the stated action levels; or If a critical decision (e.g., clean closure) will be made based on the data; or If data are to demonstrate compliance with a permit or order.
Petroleum Hydrocarbons (TRPH) & Oil & Grease	If allowed by permit, program, contract or order or If operated by a skilled individual with documented training in proper techniques. Field documentation must demonstrate that the procedure in FS 2213, section 4 was followed without deviation.	Only if allowed by permit, program, contract or order as samples should be collected into the container without intermediate devices.	Unless allowed by permit, program, contract or order.

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FS 2200 Groundwater Sampling

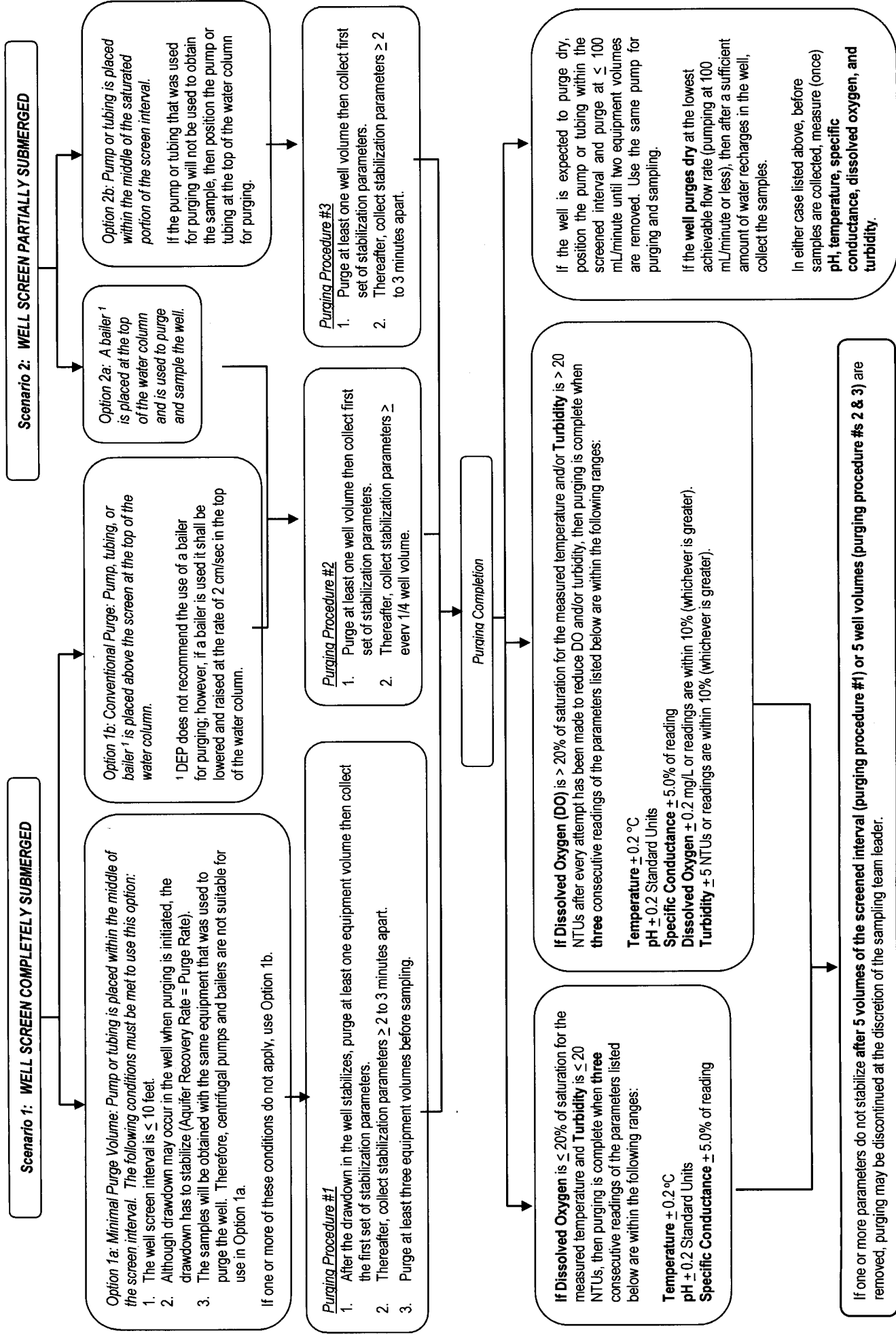
• ANALYTE GROUP(S)	• PURGING (Not Recommended)	• SAMPLING	
		Use:	Not Recommended:
Biologicals Inorganic Non-Metallics Aggregate Organics Microbiological Physical and Aggregate Properties	If allowed by permit, program, contract or order or If operated by a skilled individual with documented training in proper techniques. Field documentation must demonstrate that the procedure in FS 2213, section 4 was followed without deviation.	If all analytes collected from the well can be collected with a bailer; or If collected <u>after</u> collecting all analytes that require the use of a pump.	Before collecting any analytes that must be collected with a pump.
Ultra-Trace Metals	Never	Never	

Figure FS 2200-1
Pump and Trap for Extractable Organics



Groundwater Purging Procedures

Figure FS 2200-2



Pressley, Miriam

From: Bastek, Brian
Sent: Wednesday, September 23, 2015 7:12 PM
To: Anderson, Meredith; Brian Holtzclaw
Cc: Bing, Leann
Subject: FW: questions to pass along from last evening's meeting

Information Redacted pursuant to
5 U.S.C. Section 552 (b)(5), Exemption 5,
Privileged Inter/Intra Agency Document
Specific Privilege: Deliberative Process
Privilege

Brian Bastek
Environmental Engineer
U.S. EPA, Region 4
RCRA Corrective Action and Permitting Section
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Atlanta, GA 30303
404-562-8511
bastek.brian@epa.gov

From: Marquette Wolf [mailto:mwolf@tedlyon.com]
Sent: Wednesday, September 23, 2015 12:26 PM
To: Bastek, Brian
Subject: questions to pass along from last evening's meeting

Around 120 residents met with us, many were our clients.

Most recent questions after learning the results of the first VI study:

How do we know it (outside air) is safe to breathe at these levels for any length of time?

How can anyone assess the risk with no long term studies at low concentrations?

Who will assess the risk to determine how to remove it, whether we should move out, whether we can stay out there? (This is a combination of a lot of pointed questions)

Who knows the affects of breathing this at this level for 10, 20 and 30 years?

"I was told by Ms. Anderson 5 years ago that there was nothing to worry about; she was wrong or worse. Will the EPA tell us the truth now?" I'm passing this along directly from Ms. Adams. I explained to them all, that there will be a risk assessment, and that we will check whether the risk is based upon science or guesses. That Ms. Anderson guessed in ignorance most likely. I explained they won't pull that with you this time on assessing this risk.

How do you get clean air in the homes if the outside air is contaminated?

Is it safe to drink and bathe in the water?

What types of illnesses are caused by these chemicals?

If we are sick what do we tell our doctors about being exposed?

What do we do if our house is worthless and we need to get out? Who is going to help us?

Pressley, Miriam

From: Bastek, Brian
Sent: Monday, September 21, 2015 6:26 AM
To: Anderson, Meredith
Subject: FW: Grenada Manufacturing, LLC - Submission of 2013 and 2014 Annual Reports

FYI

Brian Bastek
Environmental Engineer
U.S. EPA, Region 4
RCRA Corrective Action and Permitting Section
Resource Conservation and Restoration Division
61 Forsyth Street, SW
Atlanta, GA 30303
404-562-8511
bastek.brian@epa.gov

From: O'Connor, David A. [mailto:David.OConnor@Meritor.com]
Sent: Friday, September 18, 2015 3:01 PM
To: Bastek, Brian
Cc: dwilliams@iceindustries.com; Jim Peebles
Subject: RE: Grenada Manufacturing, LLC - Submission of 2013 and 2014 Annual Reports

Brian:

I have talked to Jim Peebles and we believe the CY2013 and CY2014 annual reports will be issued early October. At this time I do not have any questions concerning the comments to the CY2012 report. Call me should you have any questions. Thanks.

MERITOR

David A. O'Connor
Corporate Environmental Manager
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From: Bastek, Brian [mailto:Bastek.Brian@epa.gov]
Sent: Friday, September 18, 2015 1:50 PM
To: O'Connor, David A.
Cc: dwilliams@iceindustries.com
Subject: Grenada Manufacturing, LLC - Submission of 2013 and 2014 Annual Reports

Hi Dave. Hope things are well with you.

I wanted to check on the status of submitting these two reports per the attached letter. I haven't received any communications from you so I am assuming there are no questions regarding the comments. Please let me know what your timeline is regarding these submittals.

Thank you.

Brian Bastek
Environmental Engineer
U.S. EPA, Region 4
RCRA Corrective Action and Permitting Section
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Pressley, Miriam

From: Bastek, Brian
Sent: Monday, September 21, 2015 6:18 AM
To: O'Connor, David A.
Cc: dwilliams@iceindustries.com; Jim Peeples
Subject: RE: Grenada Manufacturing, LLC - Submission of 2013 and 2014 Annual Reports

Dave,
Thanks for the update.


Brian Bastek
Environmental Engineer
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RCRA Corrective Action and Permitting Section
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61 Forsyth Street, SW
Atlanta, GA 30303
404-562-8511
bastek.brian@epa.gov

From: O'Connor, David A. [mailto:David.OConnor@Meritor.com]
Sent: Friday, September 18, 2015 3:01 PM
To: Bastek, Brian
Cc: dwilliams@iceindustries.com; Jim Peeples
Subject: RE: Grenada Manufacturing, LLC - Submission of 2013 and 2014 Annual Reports

Brian:

I have talked to Jim Peeples and we believe the CY2013 and CY2014 annual reports will be issued early October. At this time I do not have any questions concerning the comments to the CY2012 report. Call me should you have any questions. Thanks.

MERITOR

David A. O'Connor
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Sent: Friday, September 18, 2015 1:50 PM
To: O'Connor, David A.
Cc: dwilliams@iceindustries.com
Subject: Grenada Manufacturing, LLC - Submission of 2013 and 2014 Annual Reports

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Thank you.

Brian Bastek
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Pressley, Miriam

From: Bastek, Brian
Sent: Friday, September 18, 2015 1:50 PM
To: O'Connor, David A.
Cc: dwilliams@iceindustries.com
Subject: Grenada Manufacturing, LLC - Submission of 2013 and 2014 Annual Reports
Attachments: 15.08.14 EPA Comment Letter for 2012 Annual Report.pdf

Hi Dave. Hope things are well with you.

I wanted to check on the status of submitting these two reports per the attached letter. I haven't received any communications from you so I am assuming there are no questions regarding the comments. Please let me know what your timeline is regarding these submittals.

Thank you.

Brian Bastek
Environmental Engineer
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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 4
ATLANTA FEDERAL CENTER
61 FORSYTH STREET
ATLANTA, GEORGIA 30303-8960

AUG 14 2015

Via Certified Mail – Return Receipt Requested

Grenada Manufacturing, LLC
c/o Mr. Donald Williams
635 Highway 332
Grenada, Mississippi 38901

Subject: Review of 2012 Annual Monitoring Report
Grenada Manufacturing, LLC
Grenada, Mississippi
MSD 007 037 278

Dear Mr. Williams:

The 2012 Annual Monitoring Report was submitted to the U.S. EPA in accordance with the 2010 Hazardous and Solid Waste Amendments (HSWA) permit for the Grenada Manufacturing, LLC site, located in Grenada, Mississippi. The EPA has reviewed this report and offers the attached comments for the preparation of the 2013 and 2014 reports.

Please review the attached comments and incorporate these modifications, in addition to the other information requested, into the 2013 and 2014 annual reports. The 2012 Annual Monitoring report should not be revised as most comments refer to conclusions and recommendations rather than format.

Thank you for your cooperation on this project as we work to develop a better understanding of site characteristics, contaminant fate and transport, and remediation effectiveness. I am available to discuss these comments with you, so please don't hesitate to contact me at 404-562-8511 or bastek.brian@epa.gov if you have any questions.

Sincerely,

A handwritten signature in black ink, appearing to read "Brian Bastek".

Brian Bastek
Corrective Action Project Manager
RCRA Corrective Action and Permitting Section

cc: Carla Brown, MDEQ

EPA Comments on the
2012 Annual Monitoring Report
Grenada Manufacturing, LLC
Grenada, Mississippi

August 11, 2015

GENERAL COMMENTS

1. The site-wide concentration contours of Chlorinated Volatile Organic Compounds (CVOCs) in the upper aquifer (Figures 3-7 through 3-10) are not properly interpreted and are not consistent with the CSM. The contours should be extended downgradient of the PRB where significant contamination is still present. As currently drawn, the figures give the false impression that the plume terminates at the PRB. Within the upgradient portion, contours of high concentration (e.g., 50,000 ug/L) are drawn in a way that implies a single, highly concentrated, and elongated hot spot area extending across the plume from near the main plant building to the Riverdale Creek, which is not consistent with the CSM. The revised CSM in Appendix E states that multiple discrete source areas downgradient of the primary sources near the main plant caused the plume to disperse to the west. Individual monitoring well data also support the CSM that there are multiple discrete source areas rather than one very high and elongated hot spot extending from east to west. In addition to the concentration contours in plan view, vertical cross sections showing vertical contaminant distribution along a few transects across the plume would be beneficial. It is recommended that the contours be revised to correctly show discrete hot spots, be extended downgradient of the PRB, and the lowest contour be the respective MCL of each CVOC. It is also recommended that select cross-sections be included showing the vertical distribution of CVOCs.
2. As discussed in Section 3.8 of the Annual Report, the current sampling protocol was evaluated during the fall 2012 sampling event, and some concerns were identified regarding the representativeness of samples collected with a bailer following the standard three-pore volume purging method used until Spring 2012. The sampling method used during the CY2012 and previous annual monitoring events may have been problematic because samples were not representative of aquifer conditions due to inadequate purging, as demonstrated by the sharp variation between the Spring (comprehensive) and Fall (a select sub-set of wells) sampling results. As stated in the report, some of the variable data obtained from wells in the past may be related to this issue. This issue should be resolved prior to continuing with the current sampling program. An appropriate sampling protocol should be developed so that year-to-year comparison of results and trend analysis are meaningful. It is recommended that the facility conduct test sampling using both bailer and low-flow sampling method to develop a comparison of the two methods at a few select wells. Seasonal variations of groundwater levels between spring and fall should be considered in the evaluation. Ideally, the baseline comparison among alternative sampling methods should be conducted within a short span of time to minimize variables. If the May 2012 sampling results are not representative of actual aquifer conditions, the facility should not wait until the next quadrennial sampling in 2016 for another comprehensive monitoring using the low-flow sampling protocol for all wells. It

is recommended that Grenada evaluate the monitoring program following a comprehensive baseline sampling, and develop a new sampling protocol using the most representative sampling method.

SPECIFIC COMMENTS

Section 1.4, Page 1-11, Site Conceptual Model

1. The generalized cross section included is the same as the one included in the prior year's report; it has not been updated based on the updated CSM that is presented in Appendix E. In particular, the cross section does not show the discontinuous intermediate clay layer that separates the Upper Aquifer in shallow and deep zones in the eastern portion of site but is absent near Riverdale Creek. The figure also shows the water table to coincide with the boundary between the upper silty clay and the Upper Aquifer, whereas the CSM and modeling states that the water table is always within the Upper Aquifer, and that the silty clay does not affect the groundwater flow characteristics. It is recommended that Grenada update the CSM and figures to be consistent with the updated CSM presented in Appendix E.

Section 1.5, Page 1-11, Report Organization

2. The summary of findings of the monitoring program should be followed by an outline of recommended changes to the monitoring program based on the findings from the CY2012 monitoring results. No recommendations are included following the list of findings in Section 4. It is recommended that Grenada revise the next Annual Report to include a separate section providing recommendations to modify the monitoring program based on the findings.

Section 2.1, Page 2-1, Groundwater Sampling

3. The summary of the groundwater sampling method implies that all sampling was conducted following the same protocol as established in the documents cited. According to Section 3.8, the sampling protocol for groundwater samples collected during the semi-annual sampling of select wells in October 2012 was different from the method followed during the comprehensive quadrennial sampling conducted in May 2012. Grenada should revise the Annual Report to discuss the sampling protocol as outlined in the revised QAPP, and any subsequent amendment to the QAPP to conduct low-flow sampling during October 2012.

Section 2.2, Page 2-1, Summary of Statistical Analysis

4. This section describes the statistical analysis conducted to comply with the facility permit. However, no background information is provided on the purpose of this analysis and why it is mandated. Provide further information on site conditions that triggered the need for the statistical analysis in the context of the facility permit, with details such as the purpose of the evaluation, and the chemicals or concerns (COCs) to be evaluated.

Section 3.1 Page 3-1, Groundwater Flow

5. As demonstrated by the contours in Figures 3-1 and to a lesser extent Figure 3-2, the hydraulic gradient is quite flat in the main plant area, with a sharp increase near Riverdale Creek. To more accurately assess the flow pattern across the site, it is recommended that Grenada revise the next Annual Report to provide separate estimates of hydraulic gradient and groundwater velocity that are needed for the eastern part of the site, and for the area upgradient of the PRB. Also, the next Annual Report should be revised to discuss if flow rates in the deep zone are expected to be similar to the shallow zone.

Section 3.2.1.1, Page 3-2, Volatile Organic Compounds

6. The text in this section only provides a qualitative assessment of VOCs. The 2012 values of VOCs are qualitatively compared to past detections; however, none of the trend charts included in Appendix C are referred to support the discussion. The text should provide a more quantitative assessment by citing the range of concentrations measured in spring and fall of 2012 and historical concentrations with references to trend charts. Revise the next Annual Report accordingly.

Section 3.5, Page 3-5, Surface Water Results

7. This section summarizes the surface water sampling results with the data presented in Table 3-7. However, no figure is referenced. Include a map showing the locations of the surface water samples that are listed in Table 3-7. The document should include a reference to Figure 2-2 for the surface water sample locations.

Section 3.8, page 3-7, Evaluation of Monitoring Programs

8. As outlined in General Comment #3, a comprehensive baseline sampling event using concurrent bailer and low-flow sampling is needed prior to permanently shifting to the low-flow sampling protocol. Otherwise, comparison of sampling results using low-flow method with historical results using bailers will provide misleading conclusions. Grenada should develop a new sampling plan following the recommendations outlined in General Comment #3.

Section 4, Page 4-1, Summary of Findings

9. The bulleted list on this page includes a bullet on MCL exceedance of metals concentrations in wells downgradient of the PRB; however, there is no bullet summarizing the CVOC concentrations exceedances downgradient of the PRB. Include a second bullet to describe all CVOCs that still exceed MCLs downgradient of the PRB.
10. The summary bullet in this section states that VOCs in surface water have reduced below MCLs and remain below MCLs in 2012. Section 3.5.1 states that cis-1,2-dichloroethelene exceeded MCL at one location in Fall 2012. Please clarify this discrepancy.

APPENDIX E

Section 2.2.2.2.2, Page 2-11 Hydrogeology in the Upper Aquifer

11. The text provides a detailed account of the numerical ranges of hydraulic gradient, porosity, and hydraulic conductivity. However, it fails to state what the range of resulting groundwater value is in feet per day. It is recommended that Appendix E be revised to provide estimates of groundwater flow rates in feet per day. If the values are not consistent with those reported in Section 3.6 of the Annual 2012 Report, the document should explain the discrepancy. The document provides a range of time estimate of the travel time from AOC A to the Riverdale Creek, but does not provide details on how this range was estimated. Revise the document to clarify how the range was estimated, and if the travel time from AOC A to Riverdale Creek takes into account the variability of the hydraulic gradient across the distance over which the travel time is estimated.

Section 2.3.2, Page 2-14, Contaminant Transport

12. The text in this section states that the gradient reversal has been observed as far east as the PRB, and that this could have resulted in the spread and widening of the plume. Temporary gradient reversal over a short distance is not likely to have caused any significant impact on the overall spread and widening of the plume. The next Annual Report should be revised to provide details regarding observed gradient reversal to support the hypothesis that gradient reversal could contribute to the widening of the plume.

Section 2.3.2.1, Page 2-15, SWMU 2: Equalization Lagoon

13. The statement that continuing transport of CVOCs of approximately the same concentration would occur at the rate of advective groundwater flow is not clear. A more accurate narrative would be that after the CVOCs released from the Equalization Lagoon initially reached the Creek, continuing transport CVOCs would result in a constant mass flux at the Creek as approximately the same concentration of CVOCs would be released from the Equalization Lagoon while it was in operation. Revise the text to clearly describe the process of continuing mass transport from the Equalization Lagoon to the Riverdale Creek.

Section 3.3, Page 3-3, Groundwater Monitoring Near the PRB

14. The discussion of concentrations in monitoring wells near the PRB in this section contradicts the information presented in Section 2.3.3. The text here states that concentrations at MW-4I dropped below MCLs in 2010. However, Section 2.3.3 stated that the most recent monitoring data show approximately 8.5 mg/L total VOCs in MW-4I, which is several orders of magnitudes higher than the respective MCLs of the three main CVOCs. Revise the text to clarify this discrepancy.
15. The document includes a thorough evaluation of flow around and through the PRB, However, no discussion of the estimated residence time of contaminated groundwater

passing through the PRB is provided. The residence time is a critical factor in evaluating the performance of a PRB (http://www.epa.gov/tio/download/rtdf/2-prbperformance_web.pdf). The estimate of contaminant resident time should be included as part of the overall hydraulic evaluation of the PRB.

16. The conclusion that the PRB panels appear effective in treating groundwater based on geochemical environment and generally low concentrations within the PRB is not supported by the discussion presented in this section. Only the data from the northern transect can be considered to support this conclusion. However, the upgradient concentration also declined after the installation of the PRB due to the effect of various source area treatments and removal actions implemented. Therefore, the concentration decrease cannot be solely attributed to the performance of the PRB. The next Annual Report should be revised to account for other contributing factors that have resulted in an overall decrease of groundwater contamination both up and downgradient of the PRB.

Section 3.4, Page 3-5, Water Level Monitoring Near PRB

17. The primary reason that PRB walls typically have higher permeability than the aquifer is because otherwise the PRB would not be able to accommodate the required flow and groundwater will bypass the PRB, and not because minimal impact to aquifer hydraulics is desired. The next Annual Report should be revised to accurately explain why PRB permeability should be higher than the surrounding aquifer material.

Section 4.1.1, In Situ Slug Testing

18. The *in-situ* slug testing of the slurry breakdown wells has produced valuable information and insight to the PRB hydraulics. The test results indicate that, currently, the conductivity of the PRB is in the same order of magnitude as that of the aquifer. However, the conductivity of the PRB after the 2005 installation was higher based on the water level graphs in Figures 3-7 to 3-10. The next Annual Report should be revised to state that the permeability of the PRB was likely higher soon after PRB installation.
19. Appendix E does not include a comparison of water levels measured in breakdown wells and in-wall wells. This evaluation would provide further insight into the PRB hydraulics. Provide a comparison of water levels measured in the slurry breakdown wells vs in-wall wells.

Section 4.1.2.3, Page 4-5, PRB Gradient Analysis

20. The analysis presented in this section is relevant to the information provided in Section 3.4 regarding water level monitoring near the PRB. Therefore, a combined and comprehensive analysis of gradients across the PRB would be better than having two different sections presenting and discussing the same general information. Grenada should consider revising Appendix E to include all data and interpretation regarding hydraulic gradient across the PRB in one section.

Section 4.2.1.4, Page 4-13, Solid Analysis

21. This section describes the results of grain size analysis and iron content analysis of core samples from the PRB. The discussion, however, does not provide any comparison of the results compared with typical ZVI PRB material. The text also does not address whether similar analyses were during the design and installation of the PRB. It is recommended that Grenada revise the next Annual Report to discuss how the grain size analysis and iron content of the PRB core samples compares with typical ZVI PRB material, and if there are any grain size analysis and iron content data available from the PRB installation phase for comparison.

Section 4.2.3, Page 4-19, Column Reactivity Measurement

22. As stated in the text, the intended performance of the PRB was to provide direct iron-catalyzed degradation of CVOCs. However, the investigation indicates that the only microbial degradation is taking place, which is not the intended mechanism. Comparable half-lives from column tests does not mean that the outcomes are comparable, as VC is not the intended final breakdown product. The assessment implies that the increased microbial population at the front face is accountable for most of the degradation within the PRB. The evidence of biodegradation, which is also occurring in the aquifer even outside of the PRB, is not justification enough to conclude that the PRB is performing well. Section 4.2.1.5 had stated that “the biological analysis of the PRB core suggest that microbial growth can be an added benefit, provided that the bacteria do not adversely impact the hydraulics or the performance of the PRB; however, the data suggest that such adverse hydraulic impacts may be occurring as a result of microbial growth.” It is recommended that Grenada revise the discussion in the next report to further address these issues and provide stronger justification for the conclusion that the PRB is still performing well despite the indication that microbial growth has negatively impacted the PRB hydraulics and there is limited evidence of any abiotic degradation.

Section 5.2, Page 5-2, Updates to the Groundwater Flow and Transport

23. This section provides a thorough description of the updates to the flow and transport model which demonstrates that not only was the model properly modified to incorporate the PRB, the hydrogeological characterization of the aquifer in the updated model is a significant improvement over the 2007 model. It is recommended that Grenada also address how the conductivity values assigned to the cells within the PRB compare with conductivity values from slug tests conducted in 2013.

Section 5.3, Page 5-5, Numerical Model Results

24. This section does not provide details of the flow calibration process or calibration statistics, mean residual, and root mean square of error. The calibration process and statistics are helpful in assessing model adequacy and reliability. Grenada should revise the next report to detail the calibration process, list the calibration statistics, and include a figure showing the observed head and modeled head distribution within the model domain.

The modeled hydraulic conductivity for the PRB is 0.1 feet/day, which is much lower than the conductivity values measured from the in-wall slug tests as discussed in Section 4.1.1, which were from 2 feet/day to 128 feet/day. Use of such low permeability and the resulting flow paths (as shown in Figure 5-12) contradict the conclusion presented later in Section 6.2 that states "The internal permeability of the PRB is somewhat higher than the permeability of the aquifer; therefore, the internal permeability of the PRB likely is not affecting flow through the PRB and the gradient conditions at and near the PRB." According to the PRB testing results presented in Section 4, only the front face of the PRB now has a permeability that is lower than the aquifer material. A separate flow simulation would be beneficial to assess the performance of the newly-installed PRB with higher conductivity values prior to permeability reduction. Grenada should address this discrepancy and revise the model as necessary, and conduct alternative simulations of the PRB prior to and after permeability reduction at the front face of the PRB.

Section 5.4, Page 5-6, Contaminant Transport

25. Appendix E does not clearly address how the degradation of CVOCs within the PRB is modeled, which is critical in simulating the fate and transport of contamination migration through the PRB. Appendix E also does not discuss any qualitative calibration conducted to calibrate or adjust the input parameters of the fate and transport model. While the calibrated flow model has provided very useful information about the PRB hydraulics and performance, it appears that currently there are too many unknowns and assumptions to produce a reliable fate and transport model at this time. Grenada should revise the next Annual Report to address all model assumptions and limitations, and only use the flow model to support the overall PRB performance evaluation until a robust fate and transport model can be developed in the future.

Section 6.2, Page 6-1, PRB Evaluation

26. The second to last conclusion in this section states that "The environment within the PRB appears to remain reactive, and dechlorination occurs at a rate similar to the rate estimated for the PRB design." This conclusion is based on degradation rates from laboratory column tests using core samples, not actual monitoring data from the PRB wall. The last conclusion states "biological reductive dechlorination at or near the ZVI interface appears to be the primary mechanism for dechlorination of chlorinated volatile organic compounds (CVOCs), as compared to abiotic dechlorination apparent in the pre-installation column studies." However, in the absence of any abiotic degradation within the PRB, the biological reductive dechlorination that is limited to the ZVI interface at the front face of the PRB cannot result in similar rate of degradation to the one estimated during the PRB design. Grenada should consider revising these conclusions unless they can be supported by stronger evidence.

Section 6.3, Page 6-2, Fate and Transport Modeling

27. All four conclusions listed in Section 6.2 are based only on the flow model and particle tracking results, and not the fate and transport model results, as stated in Appendix E. The

second conclusion “a significant portion of the total flux of impacted groundwater toward Riverdale Creek still travels through the PRB and is treated effectively by the PRB” is only partially correct as the fate and transport model was not used to simulate the degradation of CVOCs within the PRB. Revise the text in the next report so that the conclusions accurately describe model simulations and results.

Section 6.5, Page 6-3, Additional Work to be completed in 2014

28. One of the main deficiencies of the PRB identified during the PRB evaluation effort was the lack of abiotic degradation within the PRB. Grenada should revise the discussion to indicate if there are any measures that can be recommended to restore abiotic breakdown of CVOCs within the PRB, which is the ultimate performance objective of the PRB.

Pressley, Miriam

From: Bastek, Brian
Sent: Friday, September 18, 2015 11:09 AM
To: Ellis, John; Heap, Marie; Woodruff, Randall
Subject: FW: Grenada VI Field Work September 21-25
Attachments: EPA TESTING SCHEDULE SEPT 21-23.docx

FYI.

Brian Bastek
Environmental Engineer
U.S. EPA, Region 4
RCRA Corrective Action and Permitting Section
Resource Conservation and Restoration Division
61 Forsyth Street, SW
Atlanta, GA 30303
404-562-8511
bastek.brian@epa.gov

*Grenada Email
Records 010243*

From: Kathy Carollo [mailto:magkathy2@gmail.com]
Sent: Friday, September 18, 2015 10:59 AM
To: Bastek, Brian
Cc: Reid Stanford; Jim Fineis; Holtzclaw, Brian
Subject: Re: Grenada VI Field Work September 21-

I have attached next week's testing schedule. I
The phone number that was given to me
"This user does not have a yahoo account." I
left a note on her door requesting that she get in
spoken with her.

aying
ie. I
e

Thanks,
Kathy

EPA TESTING SCHEDULE

MONDAY SEPT 21, TUESDAY SEPT 22, WEDNESDAY SEPT 23

Redacted

12:00 P.M.

(b)(6)

1:30 P.M.

(b)(6)

3:00 P.M.

(b)(6)

4:30 P.M. 104 LYON DRIVE 662-230-1853 (JESSE LITTLE)
LINDA KINNEY (TENANT)

MON 6:00 P.M.

TUES 11:00 A.M.

Y

(b)(6)

WED 11:00 A.M.

7:30 P.M.

Pressley, Miriam

From: Bastek, Brian
Sent: Thursday, September 17, 2015 3:51 PM
To: Jim Brinkman
Cc: Anderson, Meredith; Holtzclaw, Brian; mwolf@tedlyon.com; 'Reid Stanford'; 'Jim Fineis'
Subject: RE: Grenada Air Sample Analyses
Attachments: OSWER Vapor Intrusion Guide - Final.pdf

Hi Jim, thanks for the email.

We are using the analyte list as stated in the approved work plan. Following the recently published final VI Technical Guide, generally, EPA recommends the site planning and data evaluation team limit chemical analyses to those vapor-forming chemicals known (based upon subsurface contaminant characterization) or reasonably expected (based upon site history) to be present as a result of a release to the subsurface environment.

Our technical folks and subject experts are in agreement with this approach.

Brian Bastek
Environmental Engineer
U.S. EPA, Region 4
RCRA Corrective Action and Permitting Section
Resource Conservation and Restoration Division
61 Forsyth Street, SW
Atlanta, GA 30303
404-562-8511
bastek.brian@epa.gov

From: Jim Brinkman [mailto:brinkman.jim@comcast.net]
Sent: Thursday, September 17, 2015 12:10 PM
To: Bastek, Brian
Cc: Anderson, Meredith; Holtzclaw, Brian; mwolf@tedlyon.com; 'Reid Stanford'; 'Jim Fineis'
Subject: Grenada Air Sample Analyses

Brian,
One of our comments was a request to have the ambient, subslab, indoor and soil gas samples analyzed for the full TO-15 analyte list. Given the uncertainty of activities, products and chemicals used at the facility, this would be the prudent approach. Will you have all samples analyzed for the full list?
Thanks,
Jim Brinkman
(505) 550-5024

Pressley, Miriam

From: Bastek, Brian
Sent: Thursday, September 17, 2015 1:08 PM
To: Bentkowski, Ben
Subject: FW: Grenada Air Sample Analyses

(b)(5)
DPP

Brian Bastek
Environmental Engineer
U.S. EPA, Region 4
RCRA Corrective Action and Permitting Section
Resource Conservation and Restoration Division
61 Forsyth Street, SW
Atlanta, GA 30303
404-562-8511
bastek.brian@epa.gov

From: Jim Brinkman [mailto:brinkman.jim@comcast.net]
Sent: Thursday, September 17, 2015 12:10 PM
To: Bastek, Brian
Cc: Anderson, Meredith; Holtzclaw, Brian; mwolf@tedlyon.com; 'Reid Stanford'; 'Jim Fineis'
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Brian,
One of our comments was a request to have the ambient, subslab, indoor and soil gas samples analyzed for the full TO-15 analyte list. Given the uncertainty of activities, products and chemicals used at the facility, this would be the prudent approach. Will you have all samples analyzed for the full list?
Thanks,
Jim Brinkman
(505) 550-5024

Pressley, Miriam

From: Bastek, Brian
Sent: Thursday, September 17, 2015 11:28 AM
To: Ellis, John
Subject: RE: Grenada Field Work

Are we talking this morning?

Brian Bastek
Environmental Engineer
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61 Forsyth Street, SW
Atlanta, GA 30303
404-562-8511
bastek.brian@epa.gov

From: Ellis, John [<mailto:John.Ellis@arcadis.com>]
Sent: Thursday, September 17, 2015 9:04 AM
To: Bastek, Brian
Subject: RE: Grenada Field Work

Let me check with the team over here but does 10:30 EST work for you?

John

From: Bastek, Brian [<mailto:Bastek.Brian@epa.gov>]
Sent: Thursday, September 17, 2015 7:44 AM
To: Ellis, John <John.Ellis@arcadis.com>
Subject: RE: Grenada Field Work

Sure. What time is good for you?

Brian Bastek
Environmental Engineer
U.S. EPA, Region 4
RCRA Corrective Action and Permitting Section
Resource Conservation and Restoration Division
61 Forsyth Street, SW
Atlanta, GA 30303
404-562-8511
bastek.brian@epa.gov

From: Ellis, John [<mailto:John.Ellis@arcadis.com>]
Sent: Wednesday, September 16, 2015 5:11 PM
To: Bastek, Brian
Subject: RE: Grenada Field Work

Hey Brian,
Do you have any time tomorrow to discuss the VI sampling that is scheduled for next week?
Thanks,
John

From: Bastek, Brian [<mailto:Bastek.Brian@epa.gov>]
Sent: Wednesday, September 16, 2015 3:03 PM
To: Ellis, John <John.Ellis@arcadis.com>
Subject: Grenada Field Work

Hi John.

I've gotten some updates from Brian H. indirectly, but wanted to get your view of how things were going out there this week so far. Also, how's the process of obtaining Grenada City right-of-way access for the GW wells going?

Thanks. Hope things are well with you.

Brian Bastek
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Pressley, Miriam

From: Bastek, Brian
Sent: Thursday, September 17, 2015 9:07 AM
To: Ellis, John
Subject: RE: Grenada Field Work

Sure. Just give me a call on my work number.

Brian Bastek
Environmental Engineer
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61 Forsyth Street, SW
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Pressley, Miriam

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Sent: Thursday, September 17, 2015 8:44 AM
To: Ellis, John
Subject: RE: Grenada Field Work

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Brian Bastek
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Pressley, Miriam

From: Bastek, Brian
Sent: Wednesday, September 16, 2015 4:03 PM
To: Ellis, John
Subject: Grenada Field Work

Hi John.

I've gotten some updates from Brian H. indirectly, but wanted to get your view of how things were going out there this week so far. Also, how's the process of obtaining Grenada City right-of-way access for the GW wells going?

Thanks. Hope things are well with you.

Brian Bastek
Environmental Engineer
U.S. EPA, Region 4
RCRA Corrective Action and Permitting Section
Resource Conservation and Restoration Division
61 Forsyth Street, SW
Atlanta, GA 30303
404-562-8511
bastek.brian@epa.gov

Pressley, Miriam

From: Bastek, Brian
Sent: Tuesday, September 15, 2015 12:31 PM
To: Woodruff, Randall
Cc: Ellis, John; Heap, Marie; Sharp, Steve; Brian Holtzclaw
Subject: RE: Submission of the Final Revised VI IMWP for Grenada Manufacturing LLC

I think Brian Holtzclaw (who I think you have already spoke with in the field today) is going to try and set up times. Not sure what EPA can get done regarding that part. The residents' attorneys may need to do that for us since the residents won't really speak to us. Brian H. can explain more about that issue.

Brian Bastek
Environmental Engineer
U.S. EPA, Region 4
RCRA Corrective Action and Permitting Section
Resource Conservation and Restoration Division
61 Forsyth Street, SW
Atlanta, GA 30303
404-562-8511
bastek.brian@epa.gov

From: Woodruff, Randall [mailto:Randall.Woodruff@arcadis.com]
Sent: Tuesday, September 15, 2015 12:26 PM
To: Bastek, Brian
Cc: Ellis, John; Woodruff, Randall; Heap, Marie; Sharp, Steve
Subject: Re: Submission of the Final Revised VI IMWP for Grenada Manufacturing LLC

A Monday afternoon/evening start would be great. Are you setting up times to enter the homes? It's a three day process, so the earlier the first visit, the earlier we will be off site.

Thanks,
Randall Woodruff
Sent from my iPhone

On Sep 15, 2015, at 10:22 AM, Bastek, Brian <Bastek.Brian@epa.gov> wrote:

John,
Please find attached the 6 access agreement forms.

Randy,
I know you are busy this week with soil gas sampling, but wanted to forecast ahead to next week as well in order to schedule my travel. When do you anticipate starting the air sampling process? Monday afternoon/evening or Tuesday sometime? It appears that maybe two of the houses will need to be done in the evenings, but the others will be home during the days. I will be driving out on Monday and back either Thursday or Friday, depending on when the air sampling will conclude. Do you think all six houses can be done by Thursday morning?

Thanks.

Brian Bastek
Environmental Engineer
U.S. EPA, Region 4
RCRA Corrective Action and Permitting Section
Resource Conservation and Restoration Division
61 Forsyth Street, SW
Atlanta, GA 30303
404-562-8511
bastek.brian@epa.gov

From: Ellis, John [<mailto:John.Ellis@arcadis.com>]
Sent: Monday, September 14, 2015 11:26 AM
To: Bastek, Brian
Cc: Holtzclaw, Brian; Cook, George; Heap, Marie; Woodruff, Randall; Sharp, Steve; Uppencamp, Robert
Subject: RE: Submission of the Final Revised VI IMWP for Grenada Manufacturing LLC

Brian,
The field contact for this week's work is Randy Woodruff.

Randy Woodruff
Office – (317) 236-2838
Mobile (b)(6)

For the indoor air sampling, which is tentatively scheduled for the week of September 21, the team will include Randy Woodruff and Marie Heap. Remember this is totally contingent on the access agreements. Because the Suma canisters have a finite shelf life and take several days to prepare, we will need to have the access agreements in hand by closed of business Tuesday (9/15) to make this happen next week.

Marie Heap
Office – (317) 236-2849
Mobile (b)(6)

For the soil and groundwater sampling, which is scheduled for the weeks of September 28th and October 5th, George Cook will lead this effort.

George Cook
Office – (225) 292-1004
Mobile (b)(6)

Please let me know if you need any additional information.

Thanks,
John

From: Bastek, Brian [<mailto:Bastek.Brian@epa.gov>]
Sent: Monday, September 14, 2015 10:13 AM
To: Ellis, John <John.Ellis@arcadis.com>
Cc: Holtzclaw, Brian <Holtzclaw.Brian@epa.gov>
Subject: RE: Submission of the Final Revised VI IMWP for Grenada Manufacturing LLC

Thanks John.

I will need the field lead contact's information for the next several weeks. Either myself or Brian H. or perhaps someone else will be out there for oversight purposes. Can you please forward today.

Brian Bastek
Environmental Engineer
U.S. EPA, Region 4
RCRA Corrective Action and Permitting Section
Resource Conservation and Restoration Division
61 Forsyth Street, SW
Atlanta, GA 30303
404-562-8511
bastek.brian@epa.gov

From: Ellis, John [<mailto:John.Ellis@arcadis.com>]
Sent: Friday, September 11, 2015 5:41 PM
To: Bastek, Brian
Cc: Anderson, Meredith; carla_brown@deg.state.ms.us; Don Williams; Sharp, Steve
Subject: Submission of the Final Revised VI IMWP for Grenada Manufacturing LLC
Importance: High

Brian,

Don Williams asked that I forward the attached FINAL Revised IMWP for the Vapor Intrusion Assessment in Grenada, MS. We have addressed your comments from the September 4, 2015, letter.

As discussed with Meredith this morning, we are initiating the soil gas probe installation and sampling next week.

Sampling of the six residential structures is tentatively scheduled for the week of September 21th. This is dependent on the access agreements. Also, we understand USEPA will be present during sampling of the residential structures to perform the necessary outreach.

The groundwater program is scheduled to begin September 28th.

Please let us know if you have any questions.

Thanks,
John

John Ellis, P.G. | Principal Scientist / Geologist | john.ellis@arcadis-us.com

ARCADIS U.S., Inc. | 10352 Plaza Americana | Baton Rouge, LA, 70816
T: 225.292.1004 | ~~(b)(6)~~ F: 225.218.9677
Connect with us! www.arcadis-us.com | [LinkedIn](#) | [Twitter](#) | [Facebook](#)

Professional Registration / PG-TX, # 4082 / PG-LA # 408

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<Consent form

<Consent form for

<Consent form for

<Signed Consent Forms.pdf>

(b)(6)

<e.pdf>
<

This e-mail and any files transmitted with it are the property of ARCADIS U.S., Inc., and its affiliates. All rights, including without limitation copyright, are reserved. The proprietary information contained in this e-mail message, and any files transmitted with it, is intended for the use of the recipient(s) named above. If the reader of the e-mail is not the intended recipient, you are hereby notified that you have received this e-mail in error and that any review, distribution or copying of this e-mail or any files transmitted with it is strictly prohibited. If you have received this e-mail in error, please notify the sender immediately.

Pressley, Miriam

From: Bastek, Brian
Sent: Tuesday, September 15, 2015 11:23 AM
To: Ellis, John
Cc: Woodruff, Randall
Subject: RE: Submission of the Final Revised VI IMWP for Grenada Manufacturing LLC
Attachments: Consent form_ .pdf; Consent form for .pdf; Signed Consent Forms.pdf

John,
Please find attached the 6 access agreement forms.

Randy,
I know you are busy this week with soil gas sampling, but wanted to forecast ahead to next week as well in order to schedule my travel. When do you anticipate starting the air sampling process? Monday afternoon/evening or Tuesday sometime? It appears that maybe two of the houses will need to be done in the evenings, but the others will be home during the days. I will be driving out on Monday and back either Thursday or Friday, depending on when the air sampling will conclude. Do you think all six houses can be done by Thursday morning?

Thanks.

Brian Bastek
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bastek.brian@epa.gov

From: Ellis, John [mailto:John.Ellis@arcadis.com]
Sent: Monday, September 14, 2015 11:26 AM
To: Bastek, Brian
Cc: Holtzclaw, Brian; Cook, George; Heap, Marie; Woodruff, Randall; Sharp, Steve; Uppencamp, Robert
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Randy Woodruff
Office – (317) 236-2838
Mobile – (b)(6)

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Marie Heap
Office – (317) 236-2849
Mobile – (b)(6)

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George Cook
Office – (225) 292-1004
Mobile –

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Thanks,
John

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Sent: Monday, September 14, 2015 10:13 AM
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Cc: Holtzclaw, Brian <Holtzclaw.Brian@epa.gov>
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Importance: High

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The groundwater program is scheduled to begin September 28th.

Please let us know if you have any questions.

Thanks,
John

John Ellis, P.G. | Principal Scientist / Geologist | john.ellis@arcadis-us.com

ARCADIS U.S., Inc. | 10352 Plaza Americana | Baton Rouge, LA, 70816
T: 225.292.1004 | M: (b)(6) F: 225.218.9677
Connect with us! www.arcadis-us.com | [LinkedIn](#) | [Twitter](#) | [Facebook](#)

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CONSENT FOR ACCESS TO PROPERTY

Property Owner/Resident _____

(b)(6)

date

Address of Property _____

I understand that the United States Environmental Protection Agency ("EPA") is conducting a study on my property, pursuant to its response and enforcement responsibilities under the Resource Conservation and Recovery Act of 1976, as amended by the Hazardous and Solid Waste Amendments (HSWA) of 1984.

I hereby consent to allow officers, employees and authorized representatives of the EPA or Grenada Manufacturing, LLC to enter and have access to my property in order to perform investigative activities including, but not limited to, the following tasks: 1) sub-slab vapor sampling, including the installation of sampling ports into the slab or basement floor, 2) air sampling, 3) assessment, inventorying and removal of certain household containers, and 4) assessment of the residential structure. I understand that such representatives may include contractors and/or subcontractors hired by the facility, other federal and state agencies, and their agents. I also understand and agree that the above-mentioned representatives may enter upon my property at reasonable times as mutually scheduled. This consent is entirely conditioned upon the following: EPA shall ensure advance notice of the time of the sampling (at least a couple of days) and shall ensure co-sampling of samples taken from the home are provided at the request of counsel for the under-signed. If this condition is not met, this consent is void.

I recognize that performance of such actions may require some disturbance to the property and the EPA or Grenada Manufacturing, LLC will minimize any disturbance as much as possible. At the conclusion of the testing, the EPA, Grenada Manufacturing, LLC or contractor personnel will restore any disturbance to your property.

The EPA requires the responsible party's contractors to maintain comprehensive vehicle liability insurance and comprehensive general liability insurance.

This written permission is given by me voluntarily and without threats or promises of any kind. By my signature, I also acknowledge that I am fully authorized to grant such access.

By:

(b)(6) Property Owner/Resident's Name

9/11/15
Date

Signature

Main Contact Telephone Number

9:00am to 2:00pm
Best time to call:

Mailing Address _____

CONSENT FOR ACCESS TO PROPERTY

Property Owner/Resident _____

Address of Property _____

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By:

Property Owner/Resident's Name _____

Signature _____

Main Contact Telephone Number _____

Mailing Address _____

Date

Best time to call:

(b)(6)

CONSENT FOR ACCESS TO PROPERTY

Property Owner/Resident _____

Address of Property _____

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This written permission is given by me voluntarily and without threats or promises of any kind. By my signature, I also acknowledge that I am fully authorized to grant such access.

By:

Property Owner/Resident's Name _____

(b)(6) 9-11-15
Date _____

Signature _____

Main Contact Telephone Number _____

Anytime
Best time to call: _____

Mailing Address _____

(b)(6)

CONSENT FOR ACCESS TO PROPERTY

Property Owner/Resident _____

Address of Property _____

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This written permission is given by me voluntarily and without threats or promises of any kind. By my signature, I also acknowledge that I am fully authorized to grant such access.

By:

(b)(6)

Property Owner/Resident's Name _____

Date 9/9/15

Signature _____

Main Contact Telephone Number _____

anytime after 1:00 p.m.
Best time to call:

Mailing Address _____

(b)(6)

CONSENT FOR ACCESS TO PROPERTY

Property Owner/Resident _____

Address of Property _____

I understand that the United States Environmental Protection Agency ("EPA") is conducting a study on my property, pursuant to its response and enforcement responsibilities under the Resource Conservation and Recovery Act of 1976, as amended by the Hazardous and Solid Waste Amendments (HSWA) of 1984.

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This written permission is given by me voluntarily and without threats or promises of any kind. By my signature, I also acknowledge that I am fully authorized to grant such access.

By:

Property Owner/Resident's Name

7-7-5

Date

Signature

Main Contact Telephone Number

Any time

Best time to call:

Mailing Address

CONSENT FOR ACCESS TO PROPERTY

Property Owner/Resident _____

Address of Property _____

I understand that the United States Environmental Protection Agency ("EPA") is conducting a study on my property, pursuant to its response and enforcement responsibilities under the Resource Conservation and Recovery Act of 1976, as amended by the Hazardous and Solid Waste Amendments (HSWA) of 1984.

I hereby consent to allow officers, employees and authorized representatives of the EPA or Grenada Manufacturing, LLC to enter and have access to my property in order to perform investigative activities including, but not limited to, the following tasks: 1) sub-slab vapor sampling, including the installation of sampling ports into the slab or basement floor, 2) air sampling, 3) assessment, inventorying and removal of certain household containers, and 4) assessment of the residential structure. I understand that such representatives may include contractors and/or subcontractors hired by the facility, other federal and state agencies, and their agents. I also understand and agree that the above-mentioned representatives may enter upon my property at reasonable times as mutually scheduled. This consent is entirely conditioned upon the following: EPA shall ensure advance notice of the time of the sampling (at least a couple of days) and shall ensure co-sampling of samples taken from the home are provided at the request of counsel for the under-signed. If this condition is not met, this consent is void.

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This written permission is given by me voluntarily and without threats or promises of any kind. By my signature, I also acknowledge that I am fully authorized to grant such access.

Bv:

Property Owner/Resident's Name _____

Date _____

Signature _____

Main Contact Telephone Number _____

Best time to call: _____

Mailing Address _____

Pressley, Miriam

From: Bastek, Brian
Sent: Monday, September 14, 2015 6:30 PM
To: Holtzclaw, Brian; Anderson, Meredith
Subject: RE: Consent Form
Attachments: Consent form for (b) (6).pdf

Here it is. Thanks.

Brian Bastek
Environmental Engineer
U.S. EPA, Region 4
RCRA Corrective Action and Permitting Section
Resource Conservation and Restoration Division
61 Forsyth Street, SW
Atlanta, GA 30303
404-562-8511
bastek.brian@epa.gov

From: Holtzclaw, Brian
Sent: Monday, September 14, 2015 4:49 PM
To: Anderson, Meredith; Bastek, Brian
Subject: RE: Consent Form

I only have 5.....Brian, please assist, I wanted to take each one. I have 98, 100, 102, 104, 106 for the owners only. Missing 108 owner I believe. Thanks !@!

From: Anderson, Meredith
Sent: Monday, September 14, 2015 4:20 PM
To: Holtzclaw, Brian
Subject: Fwd: Consent Form

!!!!!! 😊

Sent from my iPhone

Begin forwarded message:

From: Marquette Wolf <mwolf@tedlyon.com>
Date: September 14, 2015 at 2:34:26 PM CDT
To: Brian Bastek <Bastek.Brian@epa.gov>, Meredith Clarke Anderson
<anderson.meredith@epa.gov>
Subject: Fwd: Consent Form

Last of the bunch.

M

Begin forwarded message:

From: Kathy Carollo <magkathy2@gmail.com>
Date: September 14, 2015 at 1:57:42 PM CDT
To: Marquette Wolf <mwolf@tedlyon.com>
Subject: Consent Form (b) (6)

Marquette,

I have attached the final signed consent form for

Thanks!

Kathy Carollo
Manufacturing Accountability Group
Reid Stanford, Attorney at Law
2340 Sunset Drive, Suite D
Grenada, MS 38901
(662) 307-2600
magkathy2@gmail.com

(b)(6)

CONSENT FOR ACCESS TO PROPERTY

(b)(6)

Property Owner/Resident _____

Address of Property _____

I understand that the United States Environmental Protection Agency ("EPA") is conducting a study on my property, pursuant to its response and enforcement responsibilities under the Resource Conservation and Recovery Act of 1976, as amended by the Hazardous and Solid Waste Amendments (HSWA) of 1984.

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This written permission is given by me voluntarily and without threats or promises of any kind. By my signature, I also acknowledge that I am fully authorized to grant such access.

By:

(b)(6)

Property Owner/Resident's Name

9-11-15

Date

Signature

Main Contact Telephone Number

Anytime

Best time to call:

Mailing Address

Pressley, Miriam

From: Bastek, Brian
Sent: Monday, September 14, 2015 2:03 PM
To: Ellis, John
Cc: Holtzclaw, Brian; Cook, George; Heap, Marie; Woodruff, Randall; Sharp, Steve; Uppencamp, Robert; Anderson, Meredith
Subject: RE: Submission of the Final Revised VI IMWP for Grenada Manufacturing LLC

Thanks John for the contact info.

We now have five of six access agreements, so next week is a go from that perspective. I'll forward them to you for your records.

Brian Bastek
Environmental Engineer
U.S. EPA, Region 4
RCRA Corrective Action and Permitting Section
Resource Conservation and Restoration Division
61 Forsyth Street, SW
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404-562-8511
bastek.brian@epa.gov

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Randy Woodruff
Office – (317) 236-2838
Mobile ←

(b)(6)

For the indoor air sampling, which is tentatively scheduled for the week of September 21, the team will include Randy Woodruff and Marie Heap. Remember this is totally contingent on the access agreements. Because the Suma canisters have a finite shelf life and take several days to prepare, we will need to have the access agreements in hand by closed of business Tuesday (9/15) to make this happen next week.

Marie Heap
Office – (317) 236-2849
Mobile ←

For the soil and groundwater sampling, which is scheduled for the weeks of September 28th and October 5th, George Cook will lead this effort.

George Cook

Office – (225) 292-1004

Mobile

Please let me know if you need any additional information.

Thanks,
John

From: Bastek, Brian [<mailto:Bastek.Brian@epa.gov>]
Sent: Monday, September 14, 2015 10:13 AM
To: Ellis, John <John.Ellis@arcadis.com>
Cc: Holtzclaw, Brian <Holtzclaw.Brian@epa.gov>
Subject: RE: Submission of the Final Revised VI IMWP for Grenada Manufacturing LLC

Thanks John.

I will need the field lead contact's information for the next several weeks. Either myself or Brian H. or perhaps someone else will be out there for oversight purposes. Can you please forward today.

Brian Bastek
Environmental Engineer
U.S. EPA, Region 4
RCRA Corrective Action and Permitting Section
Resource Conservation and Restoration Division
61 Forsyth Street, SW
Atlanta, GA 30303
404-562-8511
bastek.brian@epa.gov

From: Ellis, John [<mailto:John.Ellis@arcadis.com>]
Sent: Friday, September 11, 2015 5:41 PM
To: Bastek, Brian
Cc: Anderson, Meredith; carla_brown@deq.state.ms.us; Don Williams; Sharp, Steve
Subject: Submission of the Final Revised VI IMWP for Grenada Manufacturing LLC
Importance: High

Brian,

Don Williams asked that I forward the attached FINAL Revised IMWP for the Vapor Intrusion Assessment in Grenada, MS. We have addressed your comments from the September 4, 2015, letter.

As discussed with Meredith this morning, we are initiating the soil gas probe installation and sampling next week.

Sampling of the six residential structures is tentatively scheduled for the week of September 21th. This is dependent on the access agreements. Also, we understand USEPA will be present during sampling of the residential structures to perform the necessary outreach.

The groundwater program is scheduled to begin September 28th.

Please let us know if you have any questions.

Thanks,
John

John Ellis, P.G. | Principal Scientist / Geologist | john.ellis@arcadis-us.com

ARCADIS U.S., Inc. | 10352 Plaza Americana | Baton Rouge, LA, 70816
T: 225.292.1004 | F: (b)(6) 225.218.9677
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Pressley, Miriam

From: Bastek, Brian
Sent: Monday, September 14, 2015 11:13 AM
To: Ellis, John
Cc: Brian Holtzclaw
Subject: RE: Submission of the Final Revised VI IMWP for Grenada Manufacturing LLC

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The groundwater program is scheduled to begin September 28th.

Please let us know if you have any questions.

Thanks,
John

John Ellis, P.G. | Principal Scientist / Geologist | john.ellis@arcadis-us.com

(b)(6)

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Pressley, Miriam

From: Bastek, Brian
Sent: Friday, September 11, 2015 2:58 PM
To: Marquette Wolf
Cc: Anderson, Meredith; Brian Holtzclaw
Subject: RE: Consent Form

(b)(6)

OK, sounds good. And Arcadis has informed us that they will begin soil gas collection outside the neighborhood at the eight locations per the work plan you have already seen. Once I get the final revision to the work plan (hopefully today) I will forward it on to you.

Thanks. Have a good weekend.

Brian Bastek
Environmental Engineer
U.S. EPA, Region 4
RCRA Corrective Action and Permitting Section
Resource Conservation and Restoration Division
61 Forsyth Street, SW
Atlanta, GA 30303
404-562-8511
bastek.brian@epa.gov

From: Marquette Wolf [mailto:mwolf@tedlyon.com]
Sent: Friday, September 11, 2015 2:29 PM
To: Bastek, Brian
Subject: Re: Consent Form

Correction, week of 21, not next week

From: <Bastek>, Brian <Bastek.Brian@epa.gov>
Date: Friday, September 11, 2015 at 11:06 AM
To: marquette wolf <mwolf@tedlyon.com>, Meredith Clarke Anderson <anderson.meredith@epa.gov>
Subject: RE: Consent Form

(b)(6)

Thank you Marquette. We should have a schedule to you by the end of the day or sooner. Residential air sampling is tentatively scheduled for the week of September 21st.

Brian Bastek
Environmental Engineer
U.S. EPA, Region 4
RCRA Corrective Action and Permitting Section
Resource Conservation and Restoration Division
61 Forsyth Street, SW
Atlanta, GA 30303
404-562-8511
bastek.brian@epa.gov

From: Marquette Wolf [<mailto:mwolf@tedlyon.com>]
Sent: Friday, September 11, 2015 11:53 AM
To: Bastek, Brian; Anderson, Meredith
Subject: FW: Consent Form

(b)(7)(D)

Four down, two to go.

Marq

From: Kathy Carollo <magkathy2@gmail.com>
Date: Friday, September 11, 2015 at 10:34 AM
To: marquette wolf <mwolf@tedlyon.com>
Subject: Consent Form :

Marquette,

I have attached another consent form. I am still waiting on the last two - inbound.

Thank you.

Kathy Carollo
Manufacturing Accountability Group
Reid Stanford, Attorney at Law
2340 Sunset Drive, Suite D
Grenada, MS 38901
(662) 307-2600
magkathy2@gmail.com

Pressley, Miriam

From: Bastek, Brian
Sent: Friday, September 11, 2015 12:32 PM
To: Ellis, John
Subject: Grenada Final Work Plan

Hi John.

I'm back in the office today, but still not feeling great. I was wondering when I might see the final version of the work plan?

Can your forward to me at your earliest convenience?

Thanks.

Brian Bastek
Environmental Engineer
U.S. EPA, Region 4
RCRA Corrective Action and Permitting Section
Resource Conservation and Restoration Division
61 Forsyth Street, SW
Atlanta, GA 30303
404-562-8511
bastek.brian@epa.gov

Pressley, Miriam

From: Bastek, Brian
Sent: Friday, September 11, 2015 12:13 PM
To: Anderson, Meredith
Subject: FW: Consent Form (b)(6)

I guess schedule for Arcadis will depend on multiple things...

Brian Bastek
Environmental Engineer
U.S. EPA, Region 4
RCRA Corrective Action and Permitting Section
Resource Conservation and Restoration Division
61 Forsyth Street, SW
Atlanta, GA 30303
404-562-8511
bastek.brian@epa.gov

From: Marquette Wolf [<mailto:mwolf@tedlyon.com>]
Sent: Friday, September 11, 2015 12:08 PM
To: Bastek, Brian
Subject: Re: Consent Form (b)(6)

I will find out if Jim Finneus is available that week, and when.
Marq

From: <Bastek>, Brian <Bastek.Brian@epa.gov>
Date: Friday, September 11, 2015 at 11:06 AM
To: marquette wolf <mwolf@tedlyon.com>, Meredith Clarke Anderson <anderson.meredith@epa.gov>
Subject: RE: Consent Form (b)(6)

Thank you Marquette. We should have a schedule to you by the end of the day or sooner. Residential air sampling is tentatively scheduled for the week of September 21st.

Brian Bastek
Environmental Engineer
U.S. EPA, Region 4
RCRA Corrective Action and Permitting Section
Resource Conservation and Restoration Division
61 Forsyth Street, SW
Atlanta, GA 30303
404-562-8511
bastek.brian@epa.gov

From: Marquette Wolf [<mailto:mwolf@tedlyon.com>]
Sent: Friday, September 11, 2015 11:53 AM
To: Bastek, Brian; Anderson, Meredith
Subject: FW: Consent Form (b)(6)

Four down, two to go.

Marq

From: Kathy Carollo <magkathy2@gmail.com>

Date: Friday, September 11, 2015 at 10:34 AM

To: marquette wolf <mwolf@tedlyon.com>

Subject: Consent Form

(b)(6)

Marquette,

I have attached another consent form. I am still waiting on the last two - inbound.

Thank you.

Kathy Carollo

Manufacturing Accountability Group

Reid Stanford, Attorney at Law

2340 Sunset Drive, Suite D

Grenada, MS 38901

(662) 307-2600

magkathy2@gmail.com

Pressley, Miriam

From: Bastek, Brian
Sent: Friday, September 11, 2015 12:07 PM
To: Marquette Wolf; Anderson, Meredith
Subject: RE: Consent Form

(b)(6)

Thank you Marquette. We should have a schedule to you by the end of the day or sooner. Residential air sampling is tentatively scheduled for the week of September 21st.

Brian Bastek
Environmental Engineer
U.S. EPA, Region 4
RCRA Corrective Action and Permitting Section
Resource Conservation and Restoration Division
61 Forsyth Street, SW
Atlanta, GA 30303
404-562-8511
bastek.brian@epa.gov

From: Marquette Wolf [mailto:mwolf@tedlyon.com]
Sent: Friday, September 11, 2015 11:53 AM
To: Bastek, Brian; Anderson, Meredith
Subject: FW: Consent Form

Four down, two to go.

Marq

From: Kathy Carollo <magkathy2@gmail.com>
Date: Friday, September 11, 2015 at 10:34 AM
To: marquette wolf <mwolf@tedlyon.com>
Subject: Consent Form

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Thank you.

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Manufacturing Accountability Group
Reid Stanford, Attorney at Law
2340 Sunset Drive, Suite D
Grenada, MS 38901
(662) 307-2600
magkathy2@gmail.com

4675 Lakehurst Court, Suite 250 Columbus, OH 43016
(614) 339-3380 | fax (614) 389-7082 | tandmassociates.com



January 17, 2014

Ms. Meredith Clarke Anderson
Environmental Protection Agency
Sam Nunn Atlanta Federal Center
61 Forsyth Street, SW
Atlanta, GA 30303-8960

RE: Data Transmittal for Sampling Completed in the MW-20 Area of the Grenada Manufacturing Facility, Grenada, MS

Dear Ms. Anderson:

This letter is provided by T&M Associates, Inc. (T&M) on behalf of Meritor, Inc. (Meritor) to transmit data and preliminary data evaluation from sampling completed in the MW-20 Area, north of the Grenada Manufacturing Facility (Site), Grenada, Mississippi. The work included groundwater sampling of six (6) Waterloo Profiler borings, groundwater sampling of three (3) temporary wells installed at the northeast end of the line of soil gas probes, and soil gas sampling of nine (9) vapor probes installed to the southwest, south, and southeast of the neighborhood (north of the Facility). The borings, wells and soil gas probes were installed in accordance with work plans provided to and approved by the U.S. Environmental Protection Agency (USEPA).

Based on the sampling results to date, Meritor believes additional work is needed to further define groundwater impacts in this area and soil gas volatile organic compounds (VOCs) found in a small portion of the study area. This letter is provided to transmit data obtained, to date, and to provide a plan for additional work now considered necessary based on the results of the past investigations. This letter also transmits a Vapor Intrusion Health Risk Assessment (VIRA) completed using the soil gas sampling results for the probes. The VIRA has been used to confirm that the VOC results obtained from the probes do not present an imminent threat to the neighborhood north of the Site. Although an imminent threat was not identified by the VIRA, Meritor would like to proceed quickly with additional work to determine the source of soil gas trichloroethene (TCE) concentrations, identified in two probes, that were inconsistent with groundwater results in the MW-20 Area.

Following the completion of additional work in the MW-20 Area, Meritor will provide a comprehensive report, presenting the data from all phases of this investigation and providing conclusions and recommendations based on the findings. The soil gas and groundwater sampling data from the MW-20 Area (area north of the manufacturing facility) are presented and described below.

Soil Gas Sampling Results

Soil gas sampling probes were installed at 17 locations in May 2013. The intent was to sample the probes shortly after installation, but water levels in the area were high in May 2013, due to higher than average rainfall in the winter/spring of 2013. The zone of unsaturated fine sand typically encountered from 10 to 13 feet below ground surface (bgs) was not exposed at many of the probe

locations. Water levels in the area were monitored through the summer of 2013 and it was determined the water table had declined enough by the fall of 2013 that the probes could be sampled.

Of the 17 soil gas probes that had been installed, 16 were still accessible at the time of sampling in November 2013. One of the probes (VP-9) had been buried under soil due to work in the area and could not be located. An attempt was made to purge and sample soil gas from each of the 16 remaining probes. Of the 16 probes, nine (9) had sufficient permeability to allow soil gas purging and sampling with summa canisters. The other probes were either screened in zones of insufficient permeability or still contained too much water to allow soil gas sampling. Without flow of soil gas from the probe, it would not have been possible to quantify the soil gas constituent concentrations (passive sampling methods do not allow quantification). Samples were not obtained from the probes that did not transmit soil gas.

Figure 1 (Attachment 1) shows the locations of all the soil gas probes and the sampling results for the nine (9) probes that could be sampled. Of the nine (9) sampled probes, each had detections of at least one VOC constituent. Seven (7) of the nine (9) probes had VOC detections that were in the expected range, based on shallow groundwater analyses previously obtained from this area. VP-3 and VP-5 had higher than expected concentrations of TCE and cis-1,2-dichloroethene (cDCE). The VOC concentrations at these locations did not correlate well (using Henry's Law constants) with shallow groundwater VOC concentrations obtained from any of the investigation work or past groundwater sampling in this area.

It is considered likely that the VOC concentrations found in soil gas from VP-3 and VP-5 result from a vadose zone source at or near the Equalization (EQ) Basin or from areas to the south where shallow groundwater VOC concentrations are expected to be higher. Additional work will be needed to identify the source of VOCs present in soil gas at VP-3 and VP-5, and the proposed work is described below.

Meritor completed a VIRA to determine if any additional measures should be taken with respect to the soil gas concentrations identified at any of the vapor probes in terms of potential risk to residents in the neighborhood to the north of the soil gas probes. The VIRA is included as Attachment 2 to this letter. The VIRA concludes that the cumulative cancer risk for each probe was negligible and the cumulative non-cancer hazard index (HI) was negligible for all probes except VP-5, which had a hazard index right at the threshold value of one (1). Given that the HI was right at the threshold value, the source of the soil gas VOCs at VP-5 is likely in the direction of the Grenada Manufacturing Facility and the probe is about one half the distance between the Facility property line and the nearest house (about 70 feet from the house), the VOC concentrations observed are not of immediate concern. Meritor plans to complete the work described below to confirm the location of the source area. Additional investigation or corrective measures will be completed, if needed, following the investigation described below.

Groundwater Sampling Results

Groundwater samples were obtained from Waterloo Profiler borings completed in the fall of 2012 and the spring of 2013. Groundwater samples were also collected from temporary monitoring wells installed at the northeast end of the line of soil gas probes. Figures 1 and 2 show the locations of all borings, probes and temporary wells installed in what is generally described as the MW-20 Area and new wells installed between the MW-20 Area and the Facility.

Table 1 provides the results of all groundwater samples from the MW-20 Area investigations, to date. The table is set up like a cross-section to show the elevations of the samples and the analytical results from the line of borings/wells traveling from west to east. Shading is used in Table 1 to indicate samples that were either above the maximum contaminant level (MCL) for one or more of the compounds (yellow) or above 1.0 mg/L of one or more VOCs. The table also includes a blue line to indicate the approximate elevation where groundwater is present at each boring location.

The data presented in Table 1 show groundwater impacts are typically not present at the water table. Where VOC detections were present in groundwater at or near the water table, the concentrations were low. Groundwater VOC concentrations appear to increase with depth in the Waterloo Profiler borings that encountered impacted groundwater. The same appears to be the case for the nested pair of wells at the northeast end of the line of probes, TW-18s and TW-18d. Higher cDCE and TCE concentrations were observed at these wells in water obtained from beneath the intermediate clay unit (TW-18d) in comparison to shallow groundwater (TW-18s).

The highest groundwater VOC concentrations were observed in Waterloo Profiler borings WL-11, 12 and 13, with cDCE and TCE reaching concentrations greater than 1.0 mg/L at depth in these borings. While these borings showed the highest VOC concentrations, all locations other than WL-1 had some VOC detections and most locations showed an increasing trend in VOC concentration with depth. This indicates a very broad plume in the vicinity of the neighborhood, if one were to consider the plume to be traveling south to north (from the manufacturing facility toward the neighborhood). Conversely, the plume would be more compact and typical if one considers the plume to be traveling from east to west, in the direction groundwater flow has historically occurred at this site. The more reasonable and explainable pathway for groundwater flow and plume migration in the MW-20 Area is from east to west.

To further verify that groundwater does not move from the known TCE source area at the Facility in the direction of the neighborhood, a shallow and deep well were installed in a direct line from the on-site source area to the zone near the neighborhood where the highest VOC concentrations were detected (see Figure 2). Well MW-62 is a shallow well installed with 10 feet of screen just above the intermediate clay, and well MW-63 is a deep well installed with 10 feet of screen just above the lower "Marl" clay. These wells were both found to have low concentrations of cDCE and TCE, with the shallow well (MW-62) having the higher concentrations (0.12 mg/L cDCE and 0.2 mg/L TCE). In the deep well (MW-63) cDCE and TCE concentrations were 0.0039 mg/L and 0.030 mg/L, respectively. The higher concentration in the shallower well, the overall low cDCE and TCE concentrations in MW-62 and 63, and the historical and current potentiometric maps for the deep and shallow zones at the site all point to a source other than the Grenada Manufacturing Facility for the impacted groundwater found in the vicinity of the neighborhood to the north.

A more detailed discussion of potential sources for the groundwater impact found near the neighborhood will be provided in the MW-20 Area final report and in the supplemental report to the 2012 annual report for the site. Additional deep water level monitoring points have been added to the potentiometric maps for both the deep and shallow zones to allow a more detailed analysis of flow directions in both zones. Potentiometric maps drawn with the more complete data sets continue to indicate the primary flow direction in groundwater from the facility is westward toward Riverdale Creek.

Additional Work in the MW-20 Area

The primary data gap remaining in the MW-20 Area work completed to date is an understanding of the source of chlorinated VOCs (CVOCs) found in soil gas from probes VP-3 and VP-5. Groundwater sampling completed near the locations of these vapor probes, and throughout the MW-20 Area, has indicated that CVOC concentrations in shallow groundwater are very low level or not present. Based on this finding, soil gas concentrations of CVOCs in this area should also be relatively low. Seven (7) of the nine (9) probes sampled did show low CVOC concentrations, as expected. The unexpected results for VP-3 and VP-5 are likely a result of another CVOC source (not shallow groundwater). The investigation activities described below are designed to determine if shallow groundwater at or near VP-3 and VP-5 is impacted at CVOC concentrations that could result in the soil gas concentrations observed at these probes. If the groundwater is not found to be the source of higher soil gas concentrations, the investigation activities will be directed toward finding the source of CVOCs detected.

The work will consist of the following activities: (1) verification sampling of VP-3 and VP-5, (2) groundwater sampling from soil gas probes, (3) additional borings to better define the stratigraphy and the potential for soil gas migration from the EQ Basin Area to VP-3 and VP-5, and the installation of additional vapor probes in some or all of the borings to aid in determining the source of the CVOCs in soil gas.

Verification Sampling of Soil Gas Probes

VP-3 and VP-5 will be resampled to verify the soil gas concentrations at these locations and to verify the CVOC concentrations determined from the first sampling event. The water table will be higher now than it was in the fall, but it is expected resampling can occur at VP-3 and possibly at both probes. Another soil gas probe will also be resampled to confirm the relatively low concentrations found at other probes.

The samples will be obtained, handled and analyzed in the same manner as previous samples have been and in accordance with the Quality Assurance Project Plan (QAPP) and the approved protocol from the previous investigations in this area. The vapor probes will be purged to remove at least three (3) volumes of soil gas prior to the start of sampling with summa canisters. The summa canisters will be installed in line with the purging apparatus such that the flow to the canisters can be initiated without disassembly of any of the purging/sampling equipment. The canister regulators will be set to obtain a sample over a period of approximately one hour.

Quality assurance/quality control (QA/QC) samples will be collected in accordance with the Site QAPP and will include a duplicate sample, a trip blank, and an ambient blank sample. The samples will be shipped to the laboratory under standard chain-of-custody and analyzed using Method TO15. Analytical results will be validated, as described in the QAPP, and uploaded to the USEPA Region IV EQUIS database.

Groundwater Sampling from Soil Gas Probes

It is assumed that a seasonal rise in the water table has occurred since the soil gas sampling was completed in November 2013. As a result, most of the soil gas probes will have water in at least a portion of their screens. Groundwater samples will be obtained from the probes in accordance with groundwater sampling procedures described in the QAPP.

The vapor probes will be purged and sampled using disposable bailers. If a given vapor probe is sufficiently productive to allow the removal of three (3) volumes of water, a three volume purge will be used prior to collecting the groundwater sample. Field parameters including dissolved oxygen (DO), pH, conductivity, and turbidity will be measured after the removal of each volume of groundwater from the probe. If a given probe bails dry rapidly and does not recover quickly, the well will be purged to dryness and a groundwater sample will be collected after the well has recovered sufficiently, but not more than 24 hours after the well was purged dry.

Groundwater samples will be handled in accordance with standard protocol and the Site QAPP. QA/QC samples will be collected in accordance with the QAPP, including a field duplicate, equipment blank and a trip blank for the sampling event. All soil gas probes that have a sufficient column of standing water to purge will be sampled during this event.

Installation of Additional Borings/Vapor Probes

Additional borings will be installed to the east and west of VP-5 and north of VP-3 to better define the stratigraphy near these soil gas probes. Borings will also be placed in a line south of VP-5 toward the EQ Basin, and borings will be placed around the perimeter of the EQ Basin. Figure 3 shows the proposed locations for additional borings in the MW-20 Area. The actual boring locations will vary from the locations shown on Figure 3 due to field constraints and the presence of underground utilities, but the locations will generally conform to those shown in the Figure.

One important objective of these borings will be confirming the presence of a relatively uniform layer of silty-clay soil above the transition to fine sand. This transition has been observed at or below 10 feet bgs in most locations. The depth bgs of the transition to sand will be noted as well as the nature of the sand (texture, color, gradation, etc.). This information will aid in determining the likelihood the sand can serve as a pathway for soil gas transport (when it is unsaturated) from the EQ Basin area or other areas on the Facility property.

The borings will be installed with direct-push drilling using acetate sleeves to recover soil samples. The recovered soil will be logged in the field and boring logs will be developed from the field logs. The borings will be installed using methods that have been approved for previous work in the MW-20 Area as well as methods described in the Site QAPP. Soil samples will not be collected for laboratory analysis, but field screening of the soil cores will be completed and PID measurements will be recorded on the field logs. Odors or soil staining will also be noted.

In cases where borings encounter unsaturated sand zones, or zones where the sand is at a relatively high elevation and will likely be above the water table during portions of the year, soil gas probes will be installed to allow soil gas and/or groundwater samples to be collected and water level elevations to be obtained (when the water table is high enough). An attempt will be made to collect soil gas samples from all probes that are not fully saturated. Samples may be collected later in the year, when the water table is lower, for vapor probes that cannot be sampled at the time of the investigation, if additional data are needed at a later time. Groundwater samples will be collected from probes that cannot be sampled for soil gas. All soil gas and groundwater sampling will be completed in accordance with methods reviewed and approved by USEPA for previous investigations in this area and in accordance with the Site QAPP.

All boring and vapor probe locations will be surveyed by a licensed surveyor in the State of Mississippi for northing and easting location and for elevation. For probes, the ground surface elevation at the location of the probe and the top of casing elevation will be recorded.



The results of this investigation will be combined with results of previous investigations in the MW-20 Area and summarized in a final report. If additional risk assessment or other work is required, these activities will be proposed/recommended in the summary report.

Should you have any further questions regarding the recent investigation work or the proposed new work, please do not hesitate to call. Meritor would like to proceed with this work soon and would appreciate receiving approval to complete this additional work as soon as is feasible.

Sincerely,

T&M ASSOCIATES

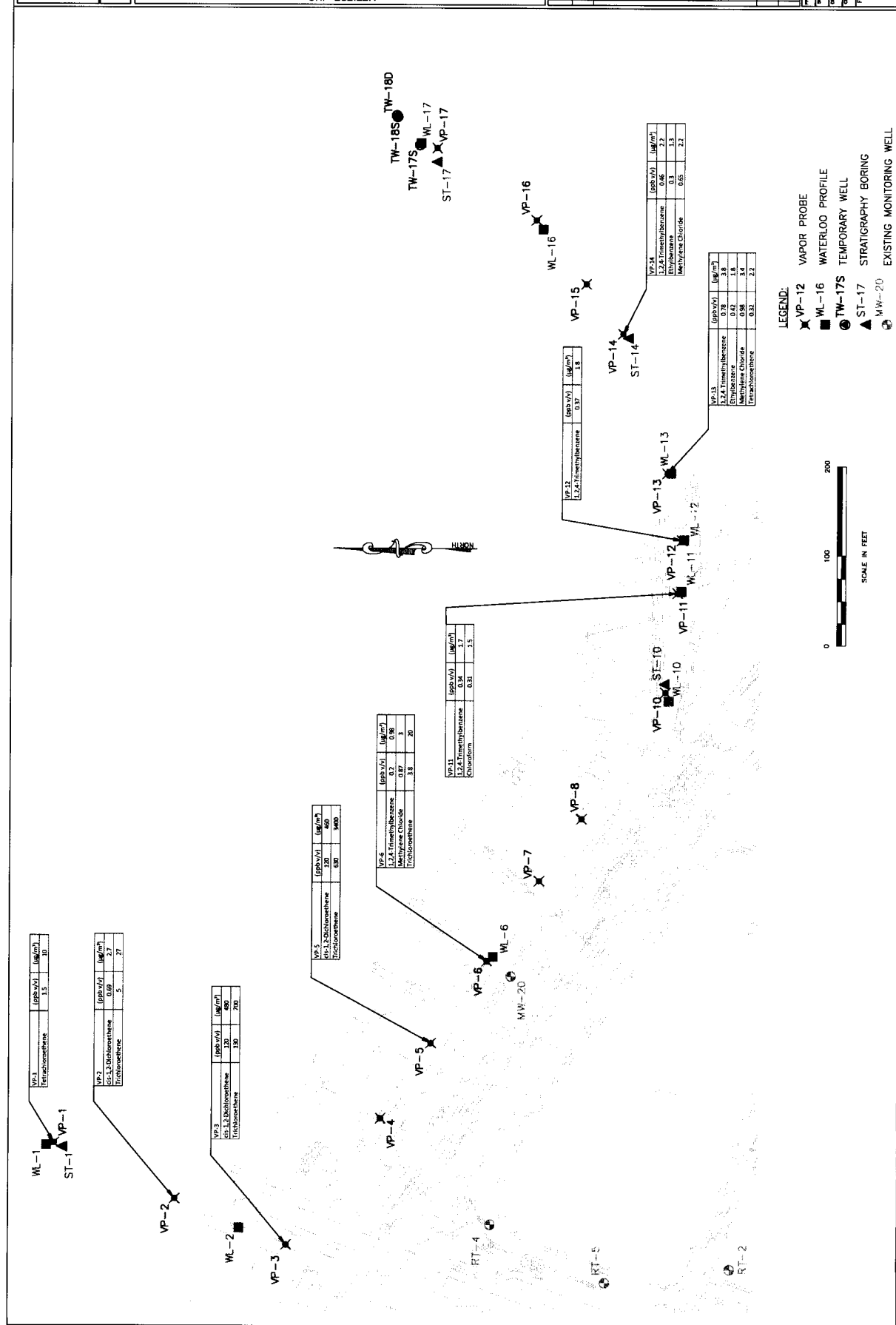
A handwritten signature in black ink, appearing to read "James A. Peeples". The signature is fluid and cursive, with a large initial "J" and a stylized "P".

James A. Peeples, P.E.
Project Manager

cc David O'Connor, Meritor, Inc.
Jeff DeLaet, T&M Associates
Ihsan Al-Fayyomi, T&M Associates

Attachments

ATTACHMENT 1 – FIGURES AND TABLES



[illegible]

FIGURE 4. Proposed Boring Locations



Table 1. Summary of Waterloo Borings Screening and Groundwater Sampling near Residential Area

Elevation ft (msl)	Boring WL-1			Boring WL-2			Boring WL-5			Well MW-20			Boring WL-10			Boring WL-11			Boring WL-12			Boring WL-13			Boring WL-14			Boring WL-15			Boring WL-17			Well TW-124			Well TW-184/4		
	Color	Lab Results (mg/L)	Tech	Color	Lab Results (mg/L)	Tech	Color	Lab Results (mg/L)	Tech	Color	Lab Results (mg/L)	Tech	Color	Lab Results (mg/L)	Tech	Color	Lab Results (mg/L)	Tech	Color	Lab Results (mg/L)	Tech	Color	Lab Results (mg/L)	Tech	Color	Lab Results (mg/L)	Tech	Color	Lab Results (mg/L)	Tech	Color	Lab Results (mg/L)	Tech	Color	Lab Results (mg/L)	Tech	Color	Lab Results (mg/L)	Tech
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Notes:

msl= mean sea level
CVOCs= chlorinated volatile organic compounds
cDCE= cis-1,2-dichloroethene
TCE= trichloroethene
Water Level

Color Tech Field Screening:

ND= not detected
LD= low level detection
MD= moderate detection
HD= high detection
CNS= could not sample
NA= not analyzed in laboratory
NS= not sampled

Shading:

Laboratory concentration > MCL
Laboratory concentration > 1.0 mg/L



ATTACHMENT 2
GRENADA MANUFACTURING MW-20 AREA VIRA MEMO



Technical Memorandum

4675 Lakehurst Court
Dublin, Ohio 43016
Tel: 614-339-3380
Fax: 614-389-7082

Prepared for: Meritor, Inc.
Project Title: MW-20 Area Vapor Intrusion Health Risk Assessment (VIRA)
Project No: MERT00010
Subject: Evaluation of VI Potential in the MW-20 Area, Grenada Manufacturing, Grenada, MS
Date: January 13, 2014
To: Linda Furlough, Dave O'Connor – Meritor, Inc.
From: James Peebles, PE, T&M Associates

Prepared by:

A handwritten signature in cursive script that reads "Paul Damian".

Paul Damian, PhD, MPH, DABT
Board Certified Toxicologist

Reviewed by:

A handwritten signature in cursive script that reads "James Peebles".

James Peebles, PE

Limitations:

This document was prepared solely for Meritor, Inc. (Meritor) in accordance with professional standards at the time the services were performed and in accordance with the contract between Meritor and T&M Associates, Inc. (T&M). This document is governed by the specific scope of work authorized by Meritor; it is not intended to be relied upon by any other party except for regulatory authorities contemplated by the scope of work. We have relied on information or instructions provided by Meritor and other parties and, unless otherwise expressly indicated, have made no independent investigation as to the validity, completeness, or accuracy of such information.

1. VAPOR INTRUSION HEALTH RISK ASSESSMENT

A vapor intrusion risk assessment (VIRA) was conducted to evaluate volatile chemicals present in soil gas with respect to a residential neighborhood located north of the Grenada Manufacturing Facility (Site) in Grenada, Mississippi. Vapor intrusion risks were determined for each of nine soil gas probes located near the southern boundary of the residential neighborhood.

1.1 BACKGROUND

Historically, the Site has been used for auto parts (wheel cover) manufacturing, first by Rockwell International Corp. from 1966 to 1985, and then by Textron Automotive Company (Textron). Textron sold the property to Grenada Manufacturing, LLC in 1999, which continued to use the site for wheel cover manufacturing until 2008. In 2008 ICE Industries, Inc. began operation of the facility, while Grenada Manufacturing retained ownership. Site investigations over the years have shown the presence of volatile organic compounds (VOCs) in soil and groundwater, particularly trichloroethene (TCE), its daughter products, and toluene (T&M Associates, Inc., [T&M] 2012).

An investigation was initiated in 2012 in the vicinity of Monitoring Well (MW-20), thought to be near the northern edge of the groundwater plume at the Site. Initial work determined that a chlorinated VOC (CVOC) plume consisting primarily of TCE and cis-1,2-dichloroethene (cDCE) was present at relatively high concentration in deep groundwater in this area and at very low concentration or below detection limits in shallow groundwater. Because the deeper impact is adjacent to and likely under a neighborhood to the north of the Site, the potential for a vapor intrusion (VI) pathway to homes in the neighborhood was investigated.

Vapor intrusion occurs when volatile chemicals present in groundwater, soil, or soil gas move upward and enter overlying buildings, including residences or commercial buildings. Such vapor intrusion may expose building occupants to health risks via the inhalation of contaminated air. The standard method for quantitatively evaluating vapor intrusion health risks is via use of the USEPA Johnson-Ettinger vapor intrusion model (USEPA, 2004). This is described in detail below.

1.2 VAPOR INTRUSION HEALTH RISK ASSESSMENT

A VIRA was prepared to evaluate potential vapor intrusion impacts on the residential neighborhood located north of the Site and in the vicinity of MW-20. The VIRA was based on soil gas data collected from nine soil gas probes placed on the southern edge of the residential properties (between the residential properties and the Site). These data and the locations of the probes are shown in Figure 1. Details regarding the field investigation activities will be presented in a comprehensive report to include all work completed in this area (referred to as the MW-20 Area). The report will be finalized following additional investigation that is currently being proposed. Cumulative vapor intrusion health risks were calculated at each probe location.

Table 1 shows the VOCs detected above practical quantitation limits (PQLs) at each of the probes. These results were collected at a depth of approximately 10 feet below ground surface (bgs). A total of seven chemicals were detected at quantifiable levels in soil gas from the nine probes, with TCE and 1,2,4-

trimethylbenzene being the most frequently detected chemicals. Probe VP-13 showed the most detected chemicals (four), followed by three detections each in VP-6 and VP-14. Figure 1 shows that the highest concentrations were detected in VP-3 and VP-5, where both TCE and its breakdown product cDCE were found at concentrations much higher than in any of the other probes.

The latest version of the USEPA Johnson-Ettinger (JE) vapor intrusion model (soil vapor screening version) was used to determine total vapor intrusion risks at each of the nine probes. The JE model is an environmental fate and transport model and is the most widely used method for quantitatively determining vapor intrusion risks. Toxicity criteria (inhalation unit risk factors and Reference Concentrations) used in the model were updated to be consistent with the toxicity criteria as presented in the latest version of the USEPA Regional Screening Level Summary Table (dated November 2013) (USEPA, 2013). As required by the JE model, the soil type in the vicinity of the probes was classified using the Soil Conservation Service soil classification system. Based on site-specific data evaluated by T&M, this soil type was considered to be Silty Clay. Slab construction was assumed for residences in the area based on site-specific information. Finally, a depth of 10 feet was assumed for the depth of the soil gas samples. All other assumptions used in the model were the default USEPA assumptions used for a residential exposure scenario.

The JE model calculates the expected indoor air concentration based on the soil gas concentration, the soil type and many other physical and chemical parameters. The JE model also calculates cancer risk (for carcinogenic chemicals only) and the Hazard Quotient (HQ), the latter being the standard measure of non-cancer health risks. A HQ of 1 or less is considered by regulatory agencies, including USEPA, to represent negligible non-cancer health risks. The potential for cumulative non-cancer health risks is indicated by the Hazard Index (HI). The HI is the sum of the HQs for each chemical detected at a probe. Thus, the HQs for each chemical detected at a given probe are summed to obtain a HI for each probe. As in the case for the HQ, a HI of 1 or less is considered by regulatory agencies to indicate negligible cumulative non-cancer health risks. Cumulative cancer risks are determined by summing the cancer risks for each carcinogenic chemical detected in each probe. A cumulative cancer risk of $1\text{E-}05$ (one in 100,000) or less is considered negligible by most regulatory agencies.

1.3 RESULTS

The results of the VIRA for each of the nine probes are summarized in Table 2. Details regarding the chemicals detected, concentrations detected, and individual chemical risks at each probe are provided in Attachment A. Table 2 shows that the cumulative cancer risks at each of the nine probes are well below $1\text{E-}05$, indicating that cumulative cancer risks are negligible based on the soil gas data available for these probes. Table 2 also shows that cumulative non-cancer risks are negligible for all probes except VP-5, which shows a HI just slightly greater than 1 (1.2) (see also Table A-4, Attachment A). It should be noted that a HI greater than 1 does not necessarily imply an imminent health risk, especially in this case where the HI is only slightly greater than 1. A representative JE model output is included in Attachment B. All JE model output is available upon request.

1.4 CONCLUSIONS

The potential for vapor intrusion health risks was evaluated at nine probes bordering a residential neighborhood north of the Site. Cumulative cancer risks at each of the probes were negligible, all being less than $1\text{E-}05$ (one in a 100,000). Cumulative non-cancer health risks at each of the probes were also negligible with the exception of VP-5. At VP-5 a HI just slightly greater than 1 (1.2) was obtained. However, because

the HI at VP-5 only slightly exceeds 1 and the probe is located approximately 70 feet from the nearest house, it does not appear that any imminent threat is present based on the highest detections obtained from the nine probes sampled. More investigation is needed to determine the source of the TCE in soil gas at VP-5 and to determine if any risk mitigation is warranted.

REFERENCES

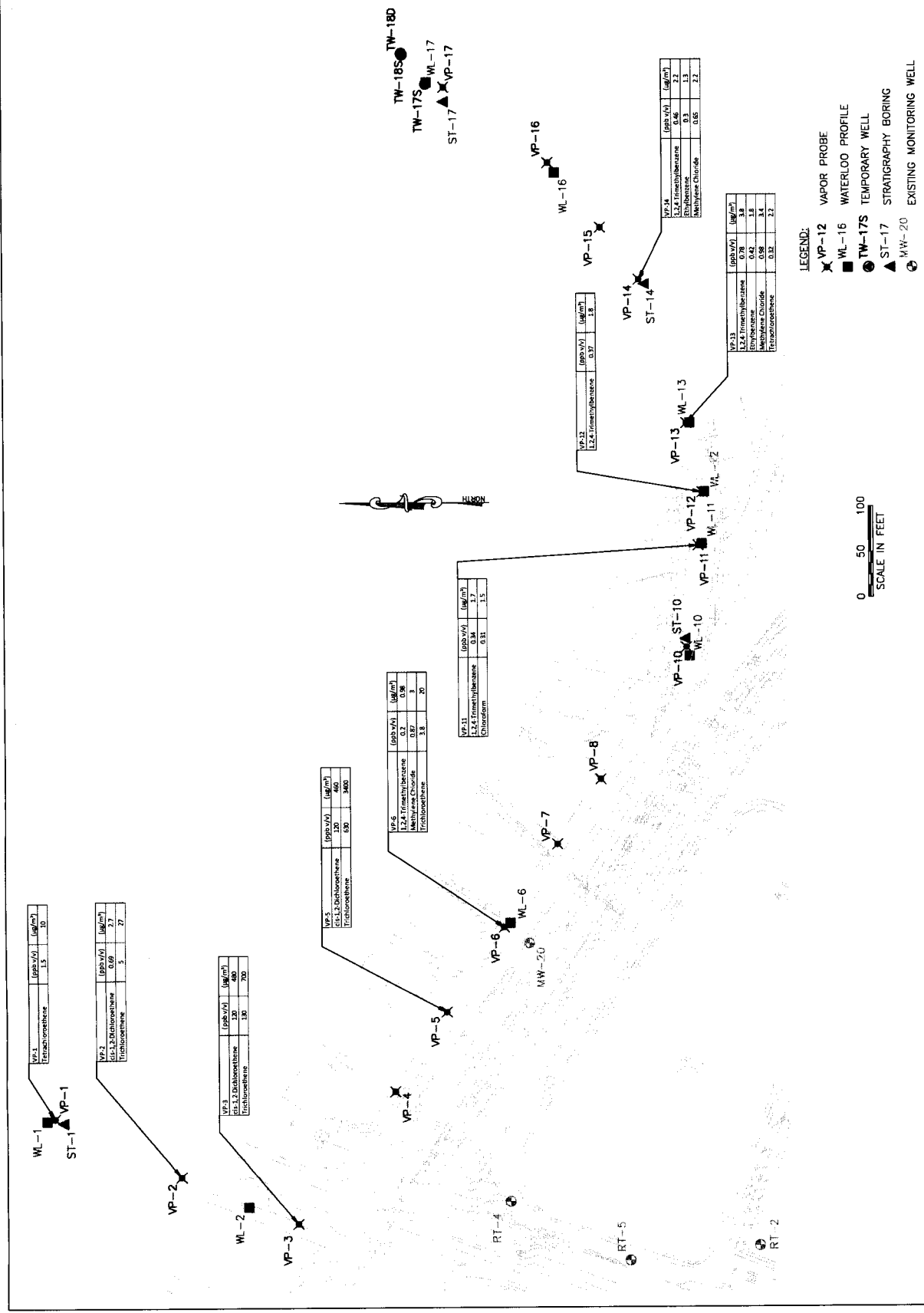
T&M. 2012. Annual Monitoring Report. Calendar Year 2012. Grenada Manufacturing, LLC. Grenada, Mississippi. Troy, Michigan.

USEPA. 2004. User's Guide for Evaluating Subsurface Vapor Intrusion into Buildings. Office of Emergency and Remedial Response. Washington, D.C.

USEPA. 2013. Regional Screening Levels (<http://www.epa.gov/region9/superfund/prg/>). November 2013. Accessed Jan. 2014.

FIGURES

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TABLES

TABLE 1

CHEMICALS DETECTED IN SOIL VAPOR AT EACH VAPOR PROBE

Chemical	Vapor Probe									
	VP-1	VP-2	VP-3	VP-5	VP-6	VP-11	VP-12	VP-13	VP-14	
Chloroform										
cis-1,2-Dichloroethene						X				
Ethylbenzene		X	X	X				X	X	
Methylene chloride					X			X	X	
Tetrachloroethene	X							X		
Trichloroethene		X	X	X	X					
1,2,4-Trimethylbenzene					X	X	X	X	X	

TABLE 2

CUMULATIVE VAPOR INTRUSION RISKS AT EACH VAPOR PROBE

Vapor Probe ID	Hazard Index ¹	Cumulative Cancer Risk ²
VP-1	1.60E-04	7.00E-10
VP-2	9.25E-03	3.20E-08
VP-3	2.49E-01	8.40E-07
VP-5	1.21E+00	4.10E-06
VP-6	6.88E-03	2.40E-08
VP-11	1.43E-04	1.30E-08
VP-12	1.40E-04	0.00E+00
VP-13	3.41E-04	1.46E-09
VP-14	1.74E-04	9.18E-10

Notes:

¹A Hazard Index of 1 or less indicates no significant risk of noncancer health effects.²A cumulative cancer risk of 1E-05 or less is considered negligible by most state agencies.

ATTACHMENT A

TABLE A-1

VAPOR INTRUSION HEALTH RISKS AT VAPOR PROBE VP-1

Chemical	Soil Vapor Concentration ($\mu\text{g}/\text{m}^3$)	Hazard Quotient	Cancer Risk
Tetrachloroethene	10	1.60E-04	7.00E-10

Hazard Index	1.60E-04	
Cumulative Cancer Risks		7.00E-10

TABLE A-2

VAPOR INTRUSION HEALTH RISKS AT VAPOR PROBE VP-2

Chemical	Soil Vapor Concentration ($\mu\text{g}/\text{m}^3$)	Hazard Quotient	Cancer Risk
cis-1,2-Dichloroethene	2.7	5.00E-05	NC
Trichloroethene	27	9.20E-03	3.20E-08

Hazard Index	9.25E-03	
Cumulative Cancer Risks		3.20E-08

NC = Non-carcinogenic chemical

TABLE A-3

VAPOR INTRUSION HEALTH RISKS AT VAPOR PROBE VP-3

Chemical	Soil Vapor Concentration ($\mu\text{g}/\text{m}^3$)	Hazard Quotient	Cancer Risk
cis-1,2-Dichloroethene	480	8.80E-03	NC
Trichloroethene	700	2.40E-01	8.40E-07

Hazard Index	2.49E-01	
Cumulative Cancer Risks		8.40E-07

NC = Non-carcinogenic chemical

TABLE A-4

VAPOR INTRUSION HEALTH RISKS AT VAPOR PROBE VP-5

Chemical	Soil Vapor Concentration ($\mu\text{g}/\text{m}^3$)	Hazard Quotient	Cancer Risk
cis-1,2-Dichloroethene	460	8.50E-03	NC
Trichloroethene	3,400	1.20E+00	4.10E-06

Hazard Index	1.21E+00	
Cumulative Cancer Risks		4.10E-06

NC = Non-carcinogenic chemical

TABLE A-5

VAPOR INTRUSION HEALTH RISKS AT VAPOR PROBE VP-6

Chemical	Soil Vapor Concentration ($\mu\text{g}/\text{m}^3$)	Hazard Quotient	Cancer Risk
Methylene chloride	3	4.20E-06	1.10E-11
Trichloroethene	20	6.80E-03	2.40E-08
1,2,4-Trimethylbenzene	0.98	7.60E-05	NC

Hazard Index	6.88E-03	
Cumulative Cancer Risks		2.40E-08

NC = Non-carcinogenic chemical

TABLE A-6

VAPOR INTRUSION HEALTH RISKS AT VAPOR PROBE VP-11

Chemical	Soil Vapor Concentration ($\mu\text{g}/\text{m}^3$)	Hazard Quotient	Cancer Risk
Chloroform	1.5	1.30E-05	1.30E-08
1,2,4-Trimethylbenzene	1.7	1.30E-04	NC

Hazard Index	1.43E-04	
Cumulative Cancer Risks		1.30E-08

NC = Non-carcinogenic chemical

TABLE A-7

VAPOR INTRUSION HEALTH RISKS AT VAPOR PROBE VP-12

Chemical	Soil Vapor Concentration ($\mu\text{g}/\text{m}^3$)	Hazard Quotient	Cancer Risk
1,2,4-Trimethylbenzene	1.8	1.40E-04	NC

Hazard Index	1.40E-04	
Cumulative Cancer Risks		0.0E+00

NC = Non-carcinogenic chemical

TABLE A-8

VAPOR INTRUSION HEALTH RISKS AT VAPOR PROBE VP-13

Chemical	Soil Vapor Concentration ($\mu\text{g}/\text{m}^3$)	Hazard Quotient	Cancer Risk
Ethylbenzene	1.8	1.20E-06	1.30E-09
Methylene chloride	3.4	4.80E-06	1.20E-11
Tetrachloroethene	2.2	3.50E-05	1.50E-10
1,2,4-Trimethylbenzene	3.8	3.00E-04	NC

Hazard Index	3.41E-04	
Cumulative Cancer Risks		1.46E-09

NC = Non-carcinogenic chemical

TABLE A-9

VAPOR INTRUSION HEALTH RISKS AT VAPOR PROBE VP-14

Chemical	Soil Vapor Concentration ($\mu\text{g}/\text{m}^3$)	Hazard Quotient	Cancer Risk
Ethylbenzene	1.3	8.50E-07	9.10E-10
Methylene chloride	2.2	3.10E-06	7.90E-12
1,2,4-Trimethylbenzene	2.2	1.70E-04	NC

Hazard Index	1.74E-04	
Cumulative Cancer Risks		9.18E-10

NC = Non-carcinogenic chemical

ATTACHMENT B

Reset to

Soil Gas Concentration Data

ENTER	ENTER	ENTER	ENTER
Chemical CAS No. (numbers only, no dashes)	Soil gas conc., C_g ($\mu\text{g}/\text{m}^3$)	OR	Soil gas conc., C_g (ppmv)
127184	1.00E+01		
			Chemical
			Tetrachloroethylene

MORE
↓

ENTER	ENTER	ENTER	ENTER
Depth below grade to bottom of enclosed space floor, L_f (15 or 200 cm)	Soil gas sampling depth below grade, L_s (cm)	Average soil temperature, T_s ($^{\circ}\text{C}$)	User-defined vadose zone soil vapor permeability, k_v (cm^2)
15	304.8	10	
			SIC

MORE
↓

ENTER	ENTER	ENTER	ENTER
Vadose zone SCS soil type	Vadose zone soil dry bulk density, ρ_b^A (g/cm^3)	Vadose zone soil total porosity, n^v (unitless)	Vadose zone soil water-filled porosity, ϕ_w^v (cm^3/cm^3)
Lookup Soil			
	1.38	0.481	0.216
SIC			

ENTER
Average vapor
flow rate into bldg.
(Leave blank to calculate)
 Q_{soil}
(L/m)
5

MORE
↓

ENTER	ENTER	ENTER	ENTER
Averaging time for carcinogens, AT_c (yrs)	Averaging time for noncarcinogens, AT_{nc} (yrs)	Exposure duration, ED (yrs)	Exposure frequency, EF (days/yr)
70	30	30	350

END

INTERMEDIATE CALCULATIONS SHEET

Source-building separation, L_r (cm)	Vadose zone air-filled porosity, $\theta_{a,v}$ (unitless)	Vadose zone effective total fluid saturation, S_{te} (unitless)	Vadose zone soil intrinsic permeability, k_i (cm ²)	Vadose zone soil relative air permeability, k_{rg} (unitless)	Vadose zone soil effective vapor permeability, k_v (cm ²)	Floor-wall seam perimeter, X_{crack} (cm)	Soil gas conc. ($\mu\text{g}/\text{m}^3$)	Bldg. ventilation rate, $Q_{building}$ (cm ³ /s)
289.8	0.265	0.284	1.48E-09	0.844	1.25E-09	4,000	1.00E+01	1.69E+04

Area of enclosed space below grade, A_g (cm ²)	Crack-to-total area ratio, τ_1 (unitless)	Crack depth below grade, Z_{crack} (cm)	Enthalpy of vaporization at ave. soil temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. soil temperature, H_{TS} (atm-cm ³ /mol)	Henry's law constant at ave. soil temperature, H_{TS} (unitless)	Vapor viscosity at ave. soil temperature, μ_{TS} (g/cm-s)	Vadose zone effective diffusion coefficient, $D_{eff,v}$ (cm ² /s)	Diffusion path length, L_d (cm)
1.00E+06	4.00E-04	15	9,553	7.81E-03	3.36E-01	1.75E-04	3.74E-03	289.8

Convection path length, L_p (cm)	Source vapor conc., C_{source} ($\mu\text{g}/\text{m}^3$)	Crack radius, r_{crack} (cm)	Average vapor flow rate into bldg., Q_{oil} (cm ³ /s)	Crack effective diffusion coefficient, D_{crack} (cm ² /s)	Area of crack, A_{crack} (cm ²)	Exponent of equivalent foundation Peclet number, $\exp(P\phi)$ (unitless)	Infinite source indoor attenuation coefficient, α (unitless)	Infinite source bldg. conc., $C_{building}$ ($\mu\text{g}/\text{m}^3$)
15	1.00E+01	0.10	8.33E+01	3.74E-03	4.00E+02	1.30E+242	6.59E-04	6.59E-03

Unit risk factor, URF ($\mu\text{g}/\text{m}^3$)⁻¹

Reference conc., RfC (mg/m³)

2.6E-07 4.0E-02

END

RESULTS SHEET

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
7.0E-10	1.6E-04

MESSAGE SUMMARY BELOW:

END

Pressley, Miriam

From: Bastek, Brian
Sent: Monday, August 31, 2015 3:55 PM
To: Anderson, Meredith
Subject: FW: Final Grenada Manufacturing LLC--Revised IM Work Plan for Vapor Intrusion Study
Attachments: 1-dw-Interim Measures Work Plan_Revised 08282015.pdf; Revised Interim Measures Work Plan Cover Letter 8-28-15.docx

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From: Don Williams [mailto:dwilliams@iceindustries.com]
Sent: Friday, August 28, 2015 5:16 PM
To: Bastek, Brian; cbrown@deq.ms.gov
Cc: Ellis, John; Karp, Jeffrey M.
Subject: FW: Final Grenada Manufacturing LLC--Revised IM Work Plan for Vapor Intrusion Study



Infrastructure · Water · Environment · Buildings

Mr. Donald Williams
Grenada Manufacturing, LLC
635 Highway 332
Grenada, Mississippi 38901

Subject:

Revised Interim Measures Work Plan – Vapor Intrusion Assessment
Grenada Manufacturing, LLC, Grenada, Mississippi.
Permit No. MSD 007 037 278

Dear Mr. Williams:

ARCADIS is pleased to provide this Revised Interim Measures Work Plan (IMWP) to Grenada Manufacturing, LLC (Grenada Manufacturing) for its facility located in Grenada, Mississippi detailing the proposed Vapor Intrusion (VI) Assessment. The revisions to the IMWP incorporate comments provided by the U.S. Environmental Protection Agency (USEPA). This IMWP has been prepared in response to the June 30, 2015, USEPA Region 4 letter to Grenada Manufacturing, in which USEPA requested performance by Grenada Manufacturing of the tasks identified therein pursuant to the company's Hazardous and Solid Waste (HSWA) permit. The IMWP outlines screening, field work, laboratory analysis, data evaluation, and reporting proposed for the scope of work, which will be conducted in accordance with the *USEPA OSWER Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Vapor Sources to Indoor Air* (USEPA June 2015).

Background

The manufacturing facility was constructed by Lyon in 1961 and sold to Rockwell International Corporation (Rockwell) in 1966. Rockwell operated a wheel cover manufacturing facility from 1966 to 1985, when the plant and property were sold to Textron, Inc. (Textron), formerly Randall Textron. In 1999, Textron sold the operations and property to Grenada Manufacturing, who continued to operate the wheel cover plant until 2008 when portions of the property were leased to ICE Industries, Inc. (ICE). Following ICE's lease of the premises, the facility was converted to a stamping plant, providing stamp-formed parts for various industries.

During prior groundwater investigation activities performed at the facility, an elevated concentration of trichloroethylene (TCE) was detected in a groundwater sample collected from off-site Monitoring Well MW-20 in a May 2012 sampling event. Seventeen soil gas ports (VP-1 through VP-17) were installed and sampled in 2013 to further investigate this area. An additional six soil gas ports (VP-101, VP-103, VP-108, VP-110, VP-112, and VP-114) were installed and sampled during May 2014.

Groundwater samples were also obtained in the fall of 2012 and the spring of 2013 from sample locations WL-1, WL-2, WL-6, WL-10, WL-11, WL-12, WL-13, WL-15,

Imagine the result

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ENVIRONMENT

Date:

August 28, 2015

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Our ref:

IN000899.0013.00001

Grenada/IN899.13/C/1/bbn

WL-16, WL-17, and TW-18S/D. The sample locations correspond to the soil gas ports (VPs) with the same number. Given the construction of the soil gas ports, groundwater is sometimes encountered in ports and water samples are collected. Water samples were collected from (VP-1, VP-2, VP-4, VP-5, VP-6, VP-7, VP-8, VP-10, VP-11, VP-12, VP-14, VP-15, VP-16, VP-17, VP-101, VP-103, VP-106, VP-107, VP-108, VP-110, VP-112, and VP-114). The data and preliminary evaluation from the sampling were submitted to USEPA Region 4 in a letter dated January 17, 2014. A figure presenting the groundwater data obtained from the soil gas ports is provided in Attachment A. These data were collected using the methods described in the January 17, 2014, letter.

Figure 1 depicts the sample locations in relation to the off-site Monitoring Well MW-20 assessment area. USEPA requested that Grenada Manufacturing prepare an IMWP to evaluate the potential VI pathway in the off-site area in a letter dated June 30, 2015. An IMWP was submitted on August 3, 2015. USEPA provided comments on the IMWP in a letter dated August 20, 2015.

Scope of Work

In an effort to evaluate the potential VI pathway in the off-site area, additional air data will be collected. Samples collected will include:

- Soil gas
- Ambient air
- Indoor air from select residential buildings
- Sub-slab vapor from select residential buildings

A reconnaissance of any building where indoor air and sub-slab vapor samples will be collected will be conducted prior to sampling.

USEPA has also requested that sampling of groundwater conditions in the upper aquifer be conducted. The groundwater data collected will be reviewed to determine the extent of constituents in groundwater as well as the source of any such constituents.

Details on the sampling procedures and data evaluations are provided below.

Any additional sampling beyond what is described in this IMWP will be based on the data evaluation. The evaluation will use the multiple lines of evidence (MLE) approach described in the *USEPA OSWER Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Vapor Sources to Indoor Air* (USEPA June 2015). If the evaluation indicates that the VI pathway is incomplete, additional VI evaluation is not warranted.

Soil Gas Assessment

ARCADIS proposes to install and sample eight shallow soil gas ports as shown on Figure 1. These eight proposed off-site locations will be installed in proximity to the existing deeper soil gas ports (VP-2 through VP-6, VP-13, and VP-17), including the ones with the elevated TCE concentrations. A desktop review of the available soil borings and geological cross-sections shows that an approximate 8- to 12-foot-thick surficial clay layer underlain by a sand layer is present in this area. The existing soil gas ports with detected volatile organic compound (VOC) concentrations were screened at the clay/sand interface or within the water-bearing sand layer. ARCADIS will use the data to evaluate the migration of concentrations detected in the previously installed soil gas ports.

Soil Gas Port Installation

A truck mounted Geoprobe® will be used to create an open borehole, and a 2.25-inch-diameter Macro-Core® sampler will be used to remove soil from the boring. As part of the reconnaissance, a utility locate will be requested to identify buried utilities in the vicinity of the structures and any proposed soil gas ports prior to intrusive activities. Soil will be classified in the field and certain soil samples may be collected from select borings for soil moisture analysis. Each of the soil gas ports will be installed to a depth of 6 feet below ground surface and will be screened from the 5.5-foot to 6-foot interval below ground surface. Soil gas ports will be constructed of 0.25-inch nylon tubing with 6-inch stainless steel screens. The screen will be installed with filter pack sand placed around the screen to 6 inches above the screen. Granular bentonite will be used to fill the remainder of the borehole above the screen filter pack to the surface and hydrated during installation. A protective cover will be installed at the surface. At the surface, the end of the tubing will be equipped with a Swagelok® fitting and a gas tight valve. Upon completion of the installation and sealing of each soil gas port, the volume of air in the sand pack will be calculated and approximately 3 times this volume of air will be purged using a low-flow air sampling pump set at a rate of 100 milliliters per minute (mL/min).

Soil Gas Port Sampling

A minimum of 24 hours after installation, each soil gas port will be sampled using 1-liter polished stainless steel SUMMA® canisters with calibrated flow controllers that are cleaned and certified by the laboratory. The flow controllers will be calibrated for a sampling duration of 10 minutes (≈ 80 mL/min). Approximately one to three times the dead volume of air will be purged at a rate of 100 mL/min prior to sampling using a low-flow air sampling pump. The amount and rate of dead volumes purged will be measured and recorded in the field and will remain consistent between sample locations. The sampling procedure consists of connecting the purge pump to the soil gas port, then turning it on, then opening the soil gas port valve to purge the tubing. At completion of purging, the valve on the soil gas port will be closed, the purge pump removed, and then the sampling canister and flow controller will be connected to the soil gas port. The sampling canister will be opened and then the valve on the

soil gas port will be opened. At the completion of sampling, the canister will be closed first and then the soil gas port valve. A final canister vacuum between 2 and 5 inches of mercury will signify that sample collection is complete. At the completion of each sample collection, the Summa canisters will be closed and sealed with a brass Swagelok® cap.

Meteorological data (temperature, precipitation, humidity, barometric pressure, and wind speed/direction) will be collected before and during sampling activities.

Residential VI Assessment

In addition to the supplemental soil gas investigation, ARCADIS proposes to complete VI sampling at six residential properties located on Lyon Drive (as shown on Figure 1). Work will be conducted in accordance with *the USEPA OSWER Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Vapor Sources to Indoor Air* (USEPA June 2015).

The six residential structures on Lyon Drive have been selected based on their relative proximity to known groundwater impacts (MW-20) and potential soil gas impacts (VP-2, VP-3, VP-5, VP-6). Only four of these structures are within 100 feet of the known groundwater or potential soil gas impacts (as shown on Figure 1). The other two properties, east and west of the potentially impacted area, are being assessed as a conservative measure. At this time, no preferential pathways have been identified in the area of potential impacts.

Community Outreach

Prior to engaging property owners regarding the residential VI sampling, the USEPA will conduct outreach with potentially affected community members. The purpose of this outreach will be to disseminate information regarding the Site history, constituents being assessed, vapor intrusion, sampling process, and obtaining access.

Residential VI sampling will be contingent on the USEPA obtaining approval and a signed access agreement from the property owners.

Reconnaissance of Structures

As recommended in USEPA guidance, prior to conducting sampling activities, a reconnaissance of the potentially affected structures will be performed. As appropriate, a visual inspection of the structure's interiors and exteriors will be performed to identify potential preferential pathways (such as utilities) to potential vapor migration into the structures and to identify any background sources or other factors that could affect the quality of indoor air. As part of the reconnaissance, information will be gathered from the homeowner on potential sources within each structure, ventilation systems, and building construction. A copy of the indoor air building survey and sampling form is provided in Attachment B. Identified potential background sources will be removed from the structure during the VI sampling event.

Samples collected from the residential structures will be given a unique identification to conceal the identity of the sample locations.

Review of the Grenada County Assessor records indicates that the houses along Lyon Drive are single-story buildings with slab-on-grade construction (no basements) and are less than 1,500 square feet in size. Thus, paired indoor air and sub-slab sampling is recommended at each structure.

USEPA will collect information on the residences in the community during their outreach campaign.

Indoor Air Sampling

Indoor air samples will be collected using 6-liter polished stainless steel SUMMA[®] canisters with calibrated flow controllers that are cleaned and certified by the laboratory. The canisters will utilize flow controllers calibrated for a 24-hour sample collection. During the collection process, the indoor air canister will be securely positioned at the breathing zone level for the most sensitive exposed population and located near the center of the structure. Because all six of the structures identified for the residential VI assessment are single-story, slab-on-grade construction and are less than 1,500 square feet in size, one indoor air sample location is appropriate. All indoor air samples will be collected under normal home conditions. A final canister vacuum on the flow controller between 2 and 5 inches of mercury will signify that sample collection is complete. At the completion of sampling, the canister will be closed and the flow controller removed. The canisters will be gauged with an independent gauge and the final vacuum recorded. The canister will then be closed and sealed with a brass Swagelok[®] cap.

Meteorological data (temperature, precipitation, humidity, barometric pressure, and wind speed/direction) will be collected before and during sampling activities.

Ambient Air Sampling

Ambient air samples will be collected outdoors concurrently with indoor air samples to evaluate potential background contaminant sources from outside the structures. Ambient air samples will be collected using 6-liter polished stainless steel SUMMA[®] canisters with calibrated flow controllers that are cleaned and certified by the laboratory. The canisters will utilize flow controllers calibrated for a 24-hour sample collection. During the collection process, the sample canister will be securely positioned at breathing height (approximately 5 feet above the ground). It is anticipated that all structures will not be sampled at the same time. It is proposed that, instead of collecting ambient air samples at each structure location, ambient air samples be collected at strategic locations that cover multiple structures at once. One ambient air sample will be collected upwind of multiple groups of buildings. At this time, two ambient air sample locations are proposed (Figure 1). If multiple events are required to collect indoor air samples, additional ambient air samples will be collected during these events. The location of the ambient air sample will be

determined based on wind direction at the time of sampling and the forecasted wind direction.

The ambient air sample canister will be placed so as to minimize potential contamination from extraneous sources. The canister will be positioned away from wind shields such as trees or bushes and at least 15 feet away from any buildings. Collection of the ambient air sample will follow the same methodology as described for indoor air samples.

Sub-Slab Port Installation

In accordance with USEPA guidance, a permanent sub-slab vapor port will be installed in the concrete floor near the center of the structure for collecting sub-slab vapor samples. The ports will be installed after the collection of the indoor air sample from that structure. The sub-slab vapor ports will be designed to lie flush on the upper surface of the concrete floor and to "float" in the slab to enable collection of vapors from sub-slab material in direct contact with the slab or from a pocket of air directly beneath the slab created by sub-slab material subsidence. Stainless steel Vapor Pins™ will be utilized. The Vapor Pins™ will be preassembled for each installation prior to drilling through the floor to minimize exposure time of the sub-slab soils to an open hole.

To install a sub-slab vapor port, a rotary hammer drill will be used to drill a 1.125-inch-outer-diameter hole approximately 2 inches into the floor. The inside of the 1.125-inch-outer-diameter hole will be cleaned with a damp towel and then a 0.625-inch-outer-diameter hole will be drilled through the remainder of the concrete. Once through the concrete, the drill will be allowed to penetrate an additional 2 to 3 inches into the sub-slab material. The outer-diameter hole will be cleaned once more with a damp towel. The Vapor Pins™ will be pressed into the concrete slab and sealed with the supplied non-volatile organic compound silicone sleeve. After the sub-slab vapor port is set, a small aliquot of air will be purged into a Tedlar® bag so as to not introduce potential vapors to the building interior. A protective cap will be placed on the end of the Vapor Pin™ and finished with a stainless steel thread-on flush-mount cover. Once the sub-slab vapor port is installed, it will be allowed to set for a minimum of 24-hours prior to sampling. These sub-slab vapor ports will remain in place after the initial sampling for use in future sampling events. After all sampling events have been completed, the sub-slab vapor ports will be removed and the holes will be patched.

Sub-Slab Port Sampling

The sub-slab vapor samples will be collected using 1-liter polished stainless steel SUMMA® canisters that are cleaned and certified by the laboratory with a calibrated flow controller. The flow controller will be calibrated for a sampling duration of 10 minutes (≈80 mL/min). The sub-slab samples will be collected by assembling a short (≈16 inches) length of 0.25-inch-diameter nylon tubing fitted with stainless steel Swagelok® tube connectors at each end that connect directly to the sub-slab vapor

port and the sampling canister. A stainless steel gas-tight valve will be installed near the canister end of the sample tubing. The sample assembly will be connected to the sub-slab vapor port and approximately three volumes of dead air will be purged from the sample assembly at a rate of approximately 100 mL/min prior to sampling using a 60-mL syringe into a Tedlar® bag so as to not introduce potential vapors to the building interior. The sampling canister will then be connected, opened, and then the valve on the sample assembly will be opened. A final canister vacuum on the flow controller between 2 and 5 inches of mercury will signify that sample collection is complete. At the completion of sampling, the canister will be closed first and then the sample assembly to the sub-slab vapor port valve. The canisters will be disconnected from the port and the flow controller removed. The canisters will be gauged with an independent gauge and the final vacuum recorded. The canister will then be closed and sealed with a brass Swagelok® cap.

Meteorological data (temperature, precipitation, humidity, barometric pressure, and wind speed/direction) will be collected before and during sampling activities.

Residential VI Seasonal Sampling

In accordance with USEPA guidance, multiple VI sampling events will be performed to demonstrate that the VI pathway is not complete. Thus, a second seasonal sampling event will be performed in the opposite season as the initial sampling event. The seasonal sampling event will follow the procedures detailed above for soil gas, sub-slab, indoor air, and ambient air sampling.

Air Sample Laboratory Analysis

Air samples will be analyzed for the following VOCs:

- 1,1-Dichloroethene (1,1-DCE)
- 1,2-Dichloroethane (1,2-DCA)
- cis-1,2-Dichloroethene (cis-1,2-DCE)
- trans-1,2-Dichloroethene (trans-1,2-DCE)
- Tetrachloroethene (PCE)
- 1,1,2-Trichloroethane (1,1,2-TCA)
- Trichloroethene (TCE)
- Vinyl Chloride
- Benzene
- Toluene*
- Ethylbenzene
- Xylenes*
- 1,2,4-Trimethylbenzene
- Chloroform
- Methylene Chloride

*Benzene and xylenes are being analyzed at USEPA's request to evaluate background concentrations in the structures that are being sampled.

Analysis of the air samples will use USEPA Compendium Method TO-15. Sample media will be ordered from Eurofins Air Toxics, Inc. (Eurofins) in Folsom, California, using proper quality assurance/quality control procedures and chain-of-custody protocols. Analysis of air samples will also be conducted by Eurofins. Analytical results will be reported in concentration units of parts per million by volume (ppmv) and micrograms per cubic meter ($\mu\text{g}/\text{m}^3$). Eurofins will be instructed to report data with constituent detection limits at or below screening levels. To minimize potential effects on the sample integrity, samples will be shipped within 24 hours following collection and the samples will not be chilled during storage. To improve the confidence in measured concentrations, a duplicate sample will be collected and analyzed for the same parameters as the parent samples. Duplicate samples will be collected by connecting two canisters together so that they have the same intake port. One duplicate sample will be collected per 20 samples of each media sampled, with the exception of the ambient air (e.g., one duplicate soil gas sample, one duplicate sub-slab sample, and one indoor air sample).

Leak Testing

In accordance with USEPA guidance, leak testing will be performed on the soil gas and sub-slab vapor ports. Leak testing will be accomplished by enriching the atmosphere in the immediate vicinity of the area where the port intersects the ground with a tracer gas and measure a vapor sample from the port for the presence of high concentrations (>10 percent) of the tracer gas. A shroud consisting of a 1-gallon container equipped with two gas valves will be placed over the sub-slab vapor ports and sealed to the ground with modeling clay. The tubing assembly will be passed through the shroud to the outside through a hole that will then be sealed with modeling clay. A cylinder of laboratory-grade compressed helium gas will be connected to one gas valve, and helium will be introduced to the shroud at a slow rate in order to not pressurize the shroud. A Dielectric MGD-2002 Helium Detector (or equivalent) will be used to measure the amount of helium in the shroud by inserting the detector probe into the second gas valve in the shroud. Once a minimum of 60 percent helium is detected in the shroud, the port will then be purged and the purged air will be collected in a Tedlar® bag. The helium detector will then be used to screen the sample aliquot in the Tedlar® bag. If less than 10 percent helium is detected in the Tedlar® bag, a SUMMA® canister will then be attached to the tubing assembly and the sample collected while the helium concentration within the shroud is maintained at a minimum of 60 percent. At the completion of the sample collection, an aliquot of air will be purged again from the port and screened for helium. If less than 10 percent helium is detected in the Tedlar® bag, the sample will be submitted to the laboratory for analysis. If greater than 10 percent helium is detected in the Tedlar® bag, the sample will not be analyzed. The sub-slab vapor port will be removed and reinstalled following the procedures detailed above. The sub-slab vapor port will then be leak tested and re-sampled.

Groundwater Assessment

USEPA also has requested that additional groundwater sampling be conducted in the residential neighborhood north of the facility to further assess VOC concentrations. ARCADIS proposes to install and sample six Vertical Aquifer Profiling (VAP) borings as shown on Figure 1. The purpose of these VAP borings is to further evaluate the stratification of VOC concentrations in the groundwater of the upper aquifer. Groundwater samples collected in the fall of 2012 and the spring of 2013 from sample locations WL-1, WL-2, WL-6, WL-10, WL-11, WL-12, WL-13, WL-15, WL-16, WL-17, and TW-18S/D indicated that VOC detections, if any, at or near the groundwater table are very low, with VOC concentrations increasing with depth. ARCADIS will evaluate the data from the new borings. The extent of VOCs in groundwater will be assessed and considered in the context of the MLE approach to determine whether supplemental VI assessments are needed.

Vertical Aquifer Profiling (VAP) Boring Installation and Sampling

A truck mounted Geoprobe® rig will be used to advance the six VAP borings to a depth of approximately 40 feet below ground surface (bgs). Beginning at the groundwater table (anticipated to be encountered approximately 10 to 12 feet bgs), ARCADIS will collect a grab groundwater sample at first encountered groundwater, then at 5-foot intervals to a total depth of approximately 40 feet bgs. After the samples have been collected, the Geoprobe boreholes will be properly abandoned.

As required by state law, ARCADIS will initiate the call-before-you-dig procedure at least 48 hours before the investigation is conducted to determine the location of utilities. Furthermore, a utility locate company (GPRS) will be utilized to assist in identifying the utilities in the vicinity. The VAP grab groundwater samples will be collected in a manner that will minimize interference and/or cross-impacts from the various vertical water-bearing zones within the upper aquifer. Duplicate, trip blank, and matrix spike/matrix spike duplicate samples will be collected during the sampling event for QA/QC purposes.

Groundwater Sample Laboratory Analysis

Groundwater samples will be shipped on ice under proper chain-of-custody to TestAmerica Laboratory for analysis of the following parameters:

VOCs (USEPA Method 8260):

- Trichloroethene (TCE)
- cis-1,2-Dichloroethene (Cis-1,2-DCE)
- Vinyl Chloride (VC)
- 1,2-Dichloroethane
- 1,1,-Dichloroethene

- 1,1,2-Trichloroethane
- Tetrachloroethene (PCE)
- Chloroethane
- Methylene chloride
- Acetone
- Carbon Disulfide
- 1,1-Dichloroethane
- Trans-1,2-Dichloroethene
- 1,1,1-Trichloroethane
- 1,2-Dichloropropane
- Benzene
- Toluene
- Ethylbenzene
- Xylenes (total)

Data Evaluation and Reporting

Upon receiving the air data, which should be available approximately 14 days after completion of sampling, the analytical package will be reviewed for completeness. Once reviewed, the data package will be shared with the USEPA. The data obtained from this VI assessment will be evaluated and compared to the calculated Vapor Intrusion Screening Levels. Any additional sampling beyond what is described in this IMWP will be based on the data evaluation. The evaluation will use the MLE approach described in the *USEPA OSWER Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Vapor Sources to Indoor Air* (USEPA June 2015). Additionally, data will be evaluated against indoor air background concentrations as identified in the *Background Indoor Air Concentrations of Volatile Organic Compounds in North American Residences (1990-2005): A Compilation of Statistics for Assessing Vapor Intrusion* (USEPA 2011). Data from the background ambient air samples collected during the event will assist in the MLE evaluation. If the evaluation of the initial and seasonal sampling events indicate that the VI pathway is incomplete, additional VI evaluation is not warranted.

Groundwater data will also be evaluated upon receipt and reviewed for completeness. The data will be summarized and the data package will be shared with the USEPA.

ARCADIS will prepare a Summary Report of the results from this assessment for Grenada Manufacturing to submit to the USEPA. Communication of the sample results to the residential property owners will be handled by the USEPA.

Schedule

Upon receiving the executed access agreements, personnel will mobilize to the area to conduct the structure reconnaissance and the sampling. In the event that potential source materials are found, they will be removed or isolated and the structure will be allowed to ventilate for approximately 24 hours. Installation and sampling of the soil gas ports are expected to take approximately 3 days. Installation of the sub-slab sample ports will take approximately 1 hour per structure. Indoor air sampling will take approximately 24 hours per structure. Assuming all activities can be coordinated during a single mobilization, the sampling effort will take approximately 7 to 8 days to complete. The groundwater sampling is anticipated to take an additional 5 to 6 days to complete and likely will occur under a separate mobilization. Data will be available approximately 14 days after completion of each of the sampling events.

Closing

If you have any questions regarding this IMWP, please do not hesitate to contact us at 225-292-1004.

Sincerely,

ARCADIS U.S., Inc.

I have reviewed this document in sufficient depth to accept full responsibility for its contents.



George E. Cook, RPG
Staff Geologist
Mississippi Registration Number 0889



John Ellis
Certified Project Manager

Attachments

Copies:

Steven Sharp – ARCADIS

Figure



Attachment A

Groundwater Analytical Data Figure





Attachment B

Building Survey and Product
Inventory Form

Building Survey and Product Inventory Form

Directions: This form must be completed for each residence or area involved in indoor air testing.

Preparer's Name: _____

Date/Time Prepared: _____

Preparer's Affiliation: _____

Phone No.: _____

Purpose of Investigation: _____

1. OCCUPANT:

Interviewed: Y / N

Last Name: _____ First Name: _____

Address: _____

County: _____

Home Phone: _____ Office Phone: _____

Number of Occupants/Persons at this Location: _____

Age of Occupants: _____

2. OWNER OR LANDLORD: (Check if Same as Occupant ☐)

Interviewed: Y / N

Last Name: _____ First Name: _____

Address: _____

County: _____

Home Phone: _____ Office Phone: _____

3. BUILDING CHARACTERISTICS:

Type of Building: (circle appropriate response)

Residential	School	Commercial/Multi-use
Industrial	Church	Other: _____

If the Property is Residential, Type? (circle appropriate response)

Ranch		2-Family 3-Family
Raised Ranch	Split Level	Colonial
Cape Cod	Contemporary	Mobile Home
Duplex	Apartment House	Townhouses/Condos
Modular	Log Home	Other: _____

If Multiple Units, How Many? _____

If the Property is Commercial, Type?

Business Type(s) _____

Does it include residences (i.e., multi-use)? Y / N If yes, how many? _____

Other Characteristics:

Number of Floors _____ Building Age _____

Is the Building Insulated? Y / N

How Air-Tight? Tight / Average / Not Tight

4. AIRFLOW:

Use air current tubes or tracer smoke to evaluate airflow patterns and qualitatively describe:

Airflow Between Floors

Airflow Near Source

Outdoor Air Infiltration

Infiltration Into Air Ducts

5. BASEMENT AND CONSTRUCTION CHARACTERISTICS: (circle all that apply)

- a. **Above grade construction:** wood frame concrete stone brick
- b. **Basement type:** full crawlspace slab other _____
- c. **Basement floor:** concrete dirt stone other _____
- d. **Basement floor:** uncovered covered covered with _____
- e. **Concrete floor:** unsealed sealed sealed with _____
- f. **Foundation walls:** poured block stone other _____
- g. **Foundation walls:** unsealed sealed sealed with _____
- h. **The basement is:** wet damp dry moldy
- i. **The basement is:** finished unfinished partially finished
- j. **Sump present?** Y / N
- k. **Water in sump?** Y / N / NA

Basement/lowest level depth below grade: _____(feet)

Identify potential soil vapor entry points and approximate size (e.g., cracks, utility ports, drains)

Are the basement walls or floor sealed with waterproof paint or epoxy coatings? Y / N

6. HEATING, VENTILATING, AND AIR CONDITIONING: (circle all that apply)

Type of heating system(s) used in this building: (circle all that apply – note primary)

Hot air circulation	Heat pump	Hot water baseboard
Space heaters	Stream radiation	Radiant floor
Electric baseboard	Wood stove	Outdoor wood boiler
Other _____		

The primary type of fuel used is:

Natural base	Fuel oil	Kerosene
Electric	Propane	Solar
Wood coal		

Domestic hot water tank fueled by: _____

Boiler/furnace located in: Basement Outdoors Main Floor Other _____

Air conditioning: Central Air Window Units Open Windows None

Are there air distribution ducts present? Y / N

Describe the supply and cold air return ductwork, and its condition where visible, including whether there is a cold air return and the tightness of duct joints. Indicate the locations on the floor plan diagram.

7. OCCUPANCY:

Is basement/lowest level occupied? Full-time Occasionally Seldom Almost Never

General Use of Each Floor (e.g., family room, bedroom, laundry, workshop, storage):

Basement _____

1st Floor _____

2nd Floor _____

3rd Floor _____

4th Floor _____

8. FACTORS THAT MAY INFLUENCE INDOOR AIR QUALITY:

- a. Is there an attached garage? Y / N
- b. Does the garage have a separate heating unit? Y / N / NA
- c. Are petroleum-powered machines or vehicles stored in the garage (e.g., lawnmower, ATV, car)?
Y / N / NA Please specify: _____
- d. Has the building ever had a fire? Y / N When? _____
- e. Is a kerosene or unvented gas space heater present? Y / N Where? _____
- f. Is there a workshop or hobby/craft area? Y / N Where & Type? _____
- g. Is there smoking in the building? Y / N How frequently? _____
- h. Have cleaning products been used recently? Y / N When & Type? _____
- i. Have cosmetic products been used recently? Y / N When & Type? _____
- j. Has painting/staining been done in the last 6 months? Y / N Where & When? _____
- k. Is there new carpet, drapes or other textiles? Y / N Where & When? _____
- l. Have air fresheners been used recently? Y / N When & Type? _____
- m. Is there a kitchen exhaust fan? Y / N If yes, where _____
- n. Is there a bathroom exhaust fan? Y / N If yes, where vented? _____
- o. Is there a clothes dryer? Y / N If yes, is it vented outside? Y / N
- p. Has there been a pesticide application? Y / N When & Type? _____

q. Are there odors in the building? Y / N

If yes, please describe: _____

Do any of the building occupants use solvents (e.g., chemical manufacturing or laboratory, auto mechanic or auto body shop, painting, fuel oil delivery, boiler mechanic, pesticide application, cosmetologist) at work? Y / N

If yes, what types of solvents are used? _____

If yes, are their clothes washed at work? Y / N

Do any of the building occupants regularly use or work at a dry-cleaning service? (circle appropriate response)

Yes, use dry-cleaning regularly (weekly) No

Yes, use dry-cleaning infrequently (monthly or less) Unknown

Yes, work at a dry-cleaning service

Is there a radon mitigation system for the building/structure? Y / N

Date of Installation: _____

Is the system active or passive? Active/Passive

Are there any Outside Contaminant Sources? (circle appropriate responses)

Contaminated site with 1000-foot radius? Y / N Specify _____

Other stationary sources nearby (e.g., gas stations, emission stacks, etc.): _____

Heavy vehicle traffic nearby (or other mobile sources): _____

9. WATER AND SEWAGE:

Water Supply: Public Water Drilled Well Driven Well Dug Well Other: _____

Sewage Disposal: Public Sewer Septic Tank Leach Field Dry Well Other: _____

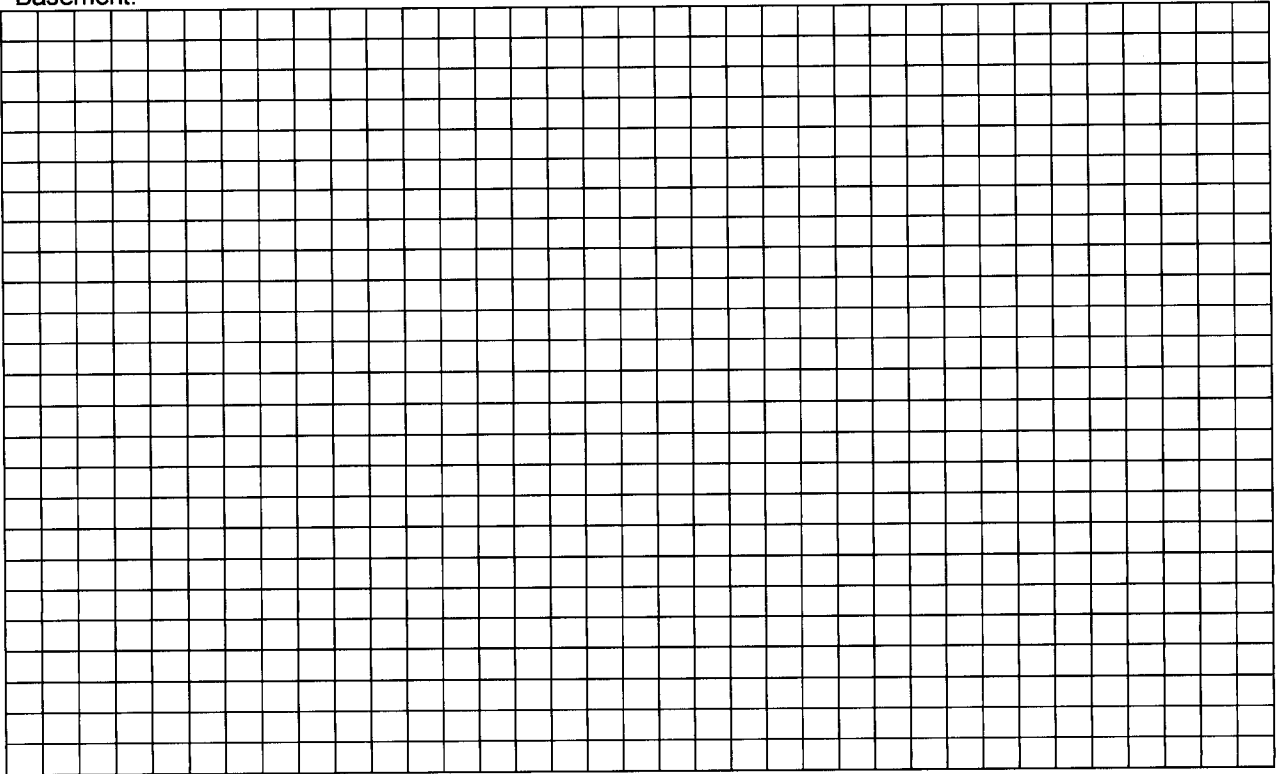
10. RELOCATION INFORMATION: (for oil spill residential emergency)

- a. Provide reasons why relocation is recommended: _____
-
- b. Residents choose to: remain in home relocate to friends/family relocate to hotel/motel
- c. Responsibility for costs associated with reimbursement explained? Y / N
- d. Relocation package provided and explained to residents? Y / N

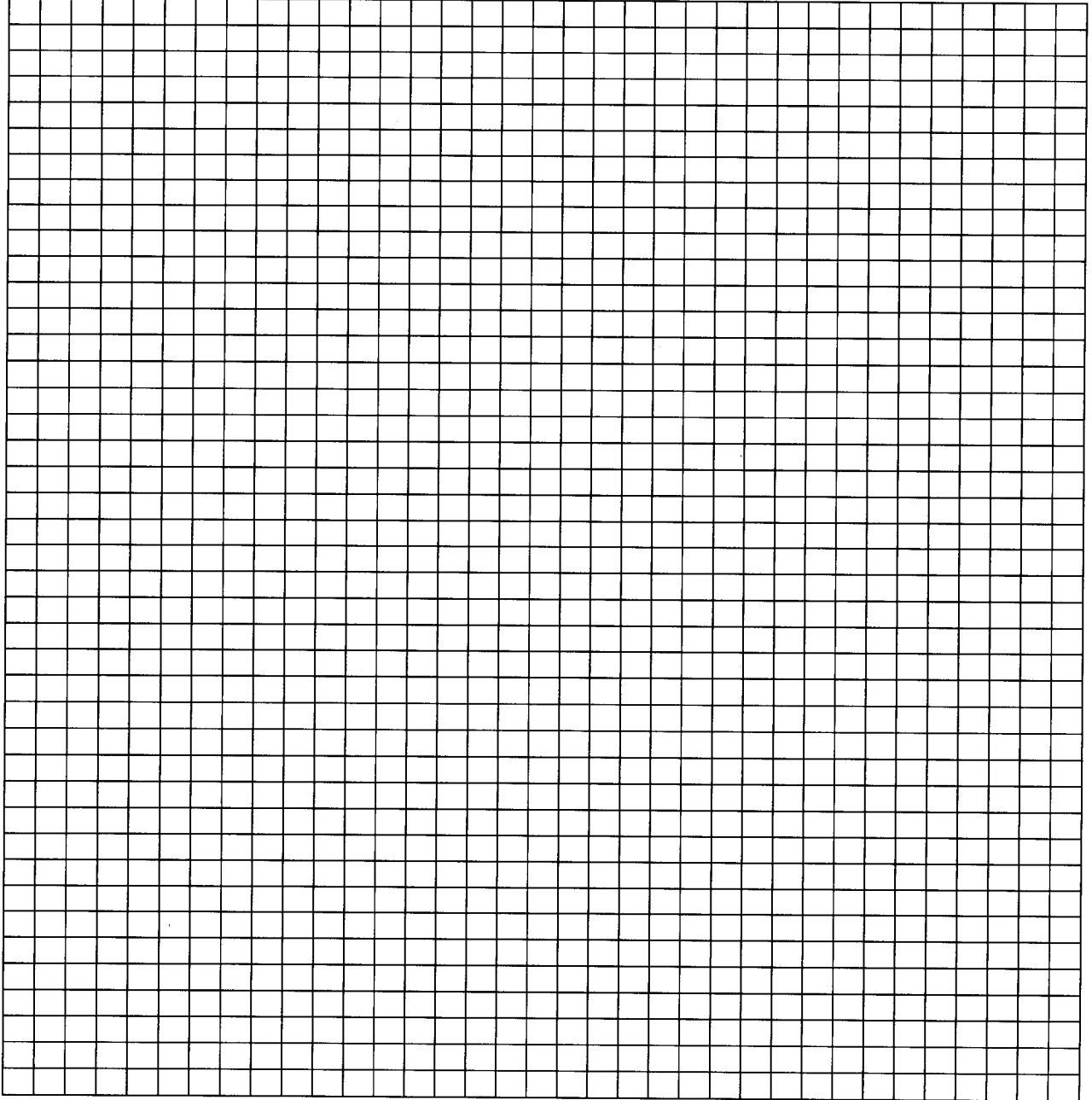
11. FLOOR PLANS:

Draw a plan view sketch of the basement and first floor of the building. Indicate air sampling locations, possible indoor air pollution sources and PID meter readings. If the building does not have a basement, please note.

Basement:



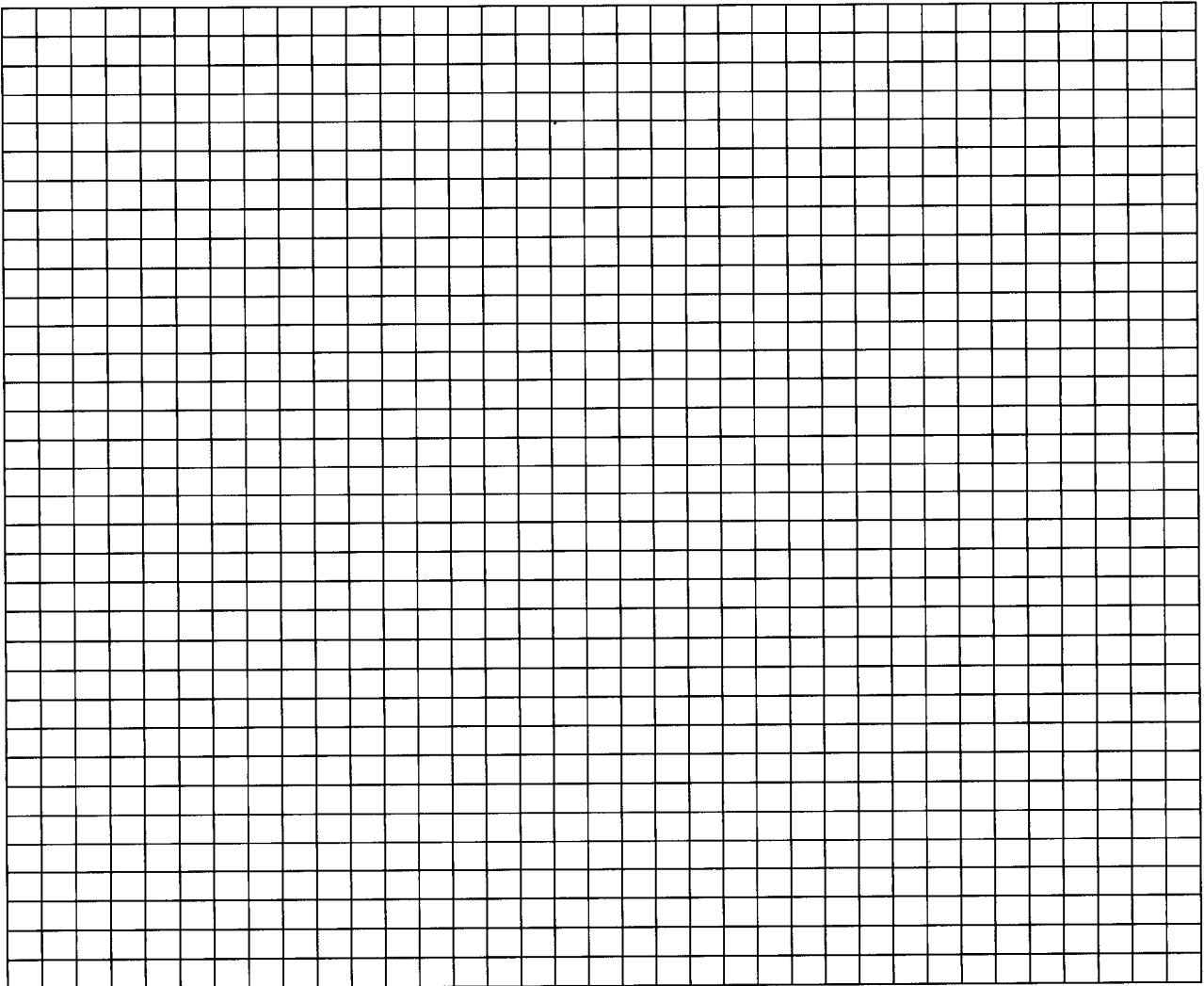
First Floor:



12. OUTDOOR PLOT:

Draw a sketch of the area surrounding the building being sampled. If applicable, provide information on spill locations, potential air contamination sources (industries, gas stations, repair shops, landfills, etc.), outdoor air sampling location(s), and PID meter readings.

Also indicate compass direction, wind direction and speed during sampling, the locations of the well and septic system, if applicable, and a qualifying statement to help locate the site on a topographic map.



Grenada Manufacturing, LLC

**635 Hwy 332
Grenada, Ms 38901**

August 28, 2015

Via Electronic Mail and Overnight Delivery
Return Receipt Requested

Mr. Brian Bastek (bastek.brian@epa.gov)
RCRA Corrective Action and Permitting Section
RCRA Cleanup and Brownfields Branch
U.S. Environmental Protection Agency
Region 4, Atlanta Federal Center
61 Forsyth Street
Atlanta, GA 30303-8960

Re: Submission of Revised Interim Measures Work Plan
EPA HSWA Permit No. MSD 007 037 278, July 29, 2010
Grenada Manufacturing, LLC, Grenada, Mississippi

Dear Mr. Bastek:

On behalf of Grenada Manufacturing, LLC, I have enclosed the Revised Interim Measures Work Plan requested in your letter of August 20, 2015. The revisions address the comments provided in the letter as well as comments provided during discussions with the agency. Mr. John Ellis of ARCADIS U.S., Inc., will continue to serve as the Project Manager on this matter.

Please do not hesitate to contact Mr. Ellis at 225-292-1004 if you have any questions regarding the enclosed work plan.

Sincerely,

Grenada Manufacturing, LLC
c/o Mr. Donald Williams
635 Highway 332
Grenada, MS 38901

Enclosure

cc: Ms. Carla Brown, Mississippi Department of Environmental Quality
Mr. John Ellis, ARCADIS U.S., Inc.



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 4
ATLANTA FEDERAL CENTER
61 FORSYTH STREET
ATLANTA, GEORGIA 30303-8960

AUG 20 2015

Grenada Manufacturing, LLC.
c/o John Ellis
ARCADIS U.S., Inc.
10352 Plaza Americana
Baton Rouge, LA 70816

SUBJ: EPA Comments on Vapor Intrusion Assessment - Draft Interim Measures Work Plan
Grenada Manufacturing, LLC
MSD 007 037 278
Grenada, Mississippi

Dear Mr. Ellis:

The EPA has reviewed the Grenada Manufacturing, LLC (Grenada) draft Vapor Intrusion (VI) Interim Measures Work Plan (IMWP). In addition to transmitting the enclosed comments, this letter highlights several key components of the revisions to the IMWP that will be necessary. You will recall that Brian Bastek and I discussed these matters with you by phone on Friday, August 14, 2015.

As we stated during our phone conversation, certain aspects of the revisions to the IMWP are of primary importance to the EPA; they are summarized as follows:

- Consistent with the *USEPA OSWER Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Vapor Sources to Indoor Air* (USEPA, June 2015), along with soil gas, sub-slab, indoor, and ambient air sampling, groundwater sampling is an important component of a VI investigation. A major omission of the draft IMWP is its failure to include concurrent groundwater sampling along with the VI air sampling. As described in the EPA's June 2015 guidance, data derived from groundwater and air sampling constitute information that is critical for adequately assessing the potential risks to human health associated with a VI pathway. Accordingly, please be advised that groundwater sampling throughout the area of the neighborhood must be conducted as part of, and concurrent with, the proposed VI investigation air sampling. This "multiple lines of evidence" approach is necessary in order to determine if a complete VI pathway is, or is not, present in this area. The draft VI IMWP, therefore, must be modified to reflect such sampling.
- In addition, the draft VI IMWP currently contemplates additional air sampling events based on an evaluation of the initial data obtained from the first six residences indicated on Figure 1 of the draft VI IMWP, as well as additional seasonal sampling. It is therefore necessary to modify the draft VI IMWP to include additional detail specifying the decision process that will be used to identify the need for, and locations of, the contemplated additional sampling.

- Finally, the draft VI IMWP must be amended to include a schedule of all sampling activities.

Please refer to the enclosure for additional edits to the draft VI IMWP that will need to be made, as we discussed during our phone conversation on August 14, 2015.

Due to the potentially very serious human health concerns, please update the draft VI IMWP previously submitted to the EPA and re-submit a revised VI IMWP to the EPA by August 27, 2015, so that, following review and approval by the EPA, sampling can begin by August 31, 2015. You may contact Brian Bastek of my staff at 404-562-8511 if you any questions about contents of this letter or the enclosed information.

Sincerely,

A handwritten signature in black ink, appearing to read "Meredith C. Anderson". The signature is fluid and cursive, with the first name "Meredith" being more prominent.

Meredith C. Anderson, Chief
RCRA Corrective Action and Permitting Section
Resource Conservation and Restoration Division

Enclosure

cc: Carla Brown, MDEQ
Donald Williams, Grenada Manufacturing, LLC

EPA Comments on the draft Vapor Intrusion Interim Measures Work Plan,
dated August 3, 2015
Prepared by ARCADIS for
Grenada Manufacturing, LLC
Grenada, Mississippi
8/20/15

p. 1 – Background:

Please include a brief description of the groundwater sampling that was conducted simultaneously with the soil gas sampling.

p. 2 – Scope of Work:

Groundwater sampling is an essential component of a Vapor Intrusion (VI) investigation to provide adequate “multiple lines of evidence”, along with soil gas, sub-slab, indoor, and ambient air sampling, to evaluate whether a complete VI pathway is present. Please include groundwater sampling throughout the neighborhood to provide the necessary information for informing the decision-making process for potential future sampling. Initially, a minimum of 10 wells located at key locations within and around the neighborhood must be installed and sampled for site-related constituents. A full evaluation of this data, concurrent with the air data, is required to determine the need for additional sampling.

p. 2 – Scope of Work/last sentence:

Please amend this sentence to read: *“If the evaluation indicates that the VI pathway is incomplete, additional VI evaluation is not warranted.”* It is important to understand, however, that a continued groundwater monitoring program in this area may be necessary for the purposes of understanding the nature and extent of groundwater contamination.

p. 3 – Residential VI Assessment:

In the first sentence, please specify what is meant by “VI sampling” (for instance, sub-slab and indoor air sampling). Also, in the third sentence, please specify what is meant by “potential soil gas impacts (VP-2, VP-3, VP-5, VP-6)”.

p. 3 – Community Outreach:

Please edit this section to read as follows: *“Prior to engaging property owners regarding the residential VI sampling, USEPA will conduct outreach with potentially affected community members. The purpose of this outreach will be to disseminate information regarding the Site history, the constituents being assessed, vapor intrusion and the sampling process, and obtaining sampling site access. Residential VI sampling will be contingent on USEPA obtaining approval and a signed access agreement from the property owners.”* Also, please indicate in this section that the permittee and ARCADIS will participate along with the EPA in outreach activities, as needed, and support the production of outreach materials.

p. 4 – Reconnaissance of Structures:

Please include the residential checklist as an attachment to this work plan.

p. 5 – 1st paragraph:

Please specify the total number of ambient air samples that will be collected during the first phase of the residential sampling.

p. 5 – Sub-Slab Port Installation:

Please add a clarification that sub-slab ports will be installed in a discrete location within the home to minimize disturbance, and provide a description of how the ports will be removed and that the home will be returned to its original condition, to the extent possible.

p. 6 – Residential VI Seasonal Sampling:

Please clarify that more than 2 seasonal sampling events may be necessary based on a review of the VI (air and groundwater) data. This should be reflected in the decision process (discussed below) used to determine the need for additional sampling.

p. 6 – Laboratory Analysis:

The EPA requires that for all sample analyses the Method Detection Levels be less than the most up-to-date EPA Regional Screening Levels. Laboratory analytical results should be received on a priority schedule and shared with EPA in an electronic format as soon as practicable. Also, please add benzene and xylene to the list of VOCs for analyses of all air samples.

p. 7 – 1st paragraph:

Please specify that duplicate samples will be taken for each media being sampled.

p. 7 – Data Evaluation and Reporting:

This section should include a sampling schedule and a detailed presentation of the decision process to be used to determine, using a “multiple lines of evidence approach”, whether and where additional VI sampling (including groundwater, soil gas, sub-slab/indoor air, and ambient air) are needed to confirm the presence or absence of a complete VI pathway.

p. 8 – 1st sentence:

This sentence should read “*If the evaluation of the initial and all seasonal sampling events indicate that the VI pathway is incomplete, additional VI evaluation is not warranted.*” It is important to understand, however, that a continued groundwater monitoring program in this area may be necessary for the purposes of understanding the nature and extent of groundwater contamination.

Pressley, Miriam

From: Bastek, Brian
Sent: Monday, August 31, 2015 7:03 AM
To: Holtzclaw, Brian; Anderson, Meredith
Subject: RE: Final Grenada Manufacturing LLC--Revised IM Work Plan for Vapor Intrusion Study

I will later today once it is approved by Meredith and myself.

Brian Bastek
Environmental Engineer
U.S. EPA, Region 4
RCRA Corrective Action and Permitting Section
Resource Conservation and Restoration Division
61 Forsyth Street, SW
Atlanta, GA 30303
404-562-8511
bastek.brian@epa.gov

From: Holtzclaw, Brian
Sent: Monday, August 31, 2015 7:01 AM
To: Bastek, Brian; Anderson, Meredith
Subject: RE: Final Grenada Manufacturing LLC--Revised IM Work Plan for Vapor Intrusion Study

Did we sent this off to Reid and Marquette yet, funny that rhymes... Brian

From: Bastek, Brian
Sent: Monday, August 31, 2015 6:52 AM
To: Anderson, Meredith; Holtzclaw, Brian
Subject: FW: Final Grenada Manufacturing LLC--Revised IM Work Plan for Vapor Intrusion Study

Brian Bastek
Environmental Engineer
U.S. EPA, Region 4
RCRA Corrective Action and Permitting Section
Resource Conservation and Restoration Division
61 Forsyth Street, SW
Atlanta, GA 30303
404-562-8511
bastek.brian@epa.gov

From: Don Williams [<mailto:dwilliams@iceindustries.com>]
Sent: Friday, August 28, 2015 5:16 PM
To: Bastek, Brian; cbrown@deg.ms.gov
Cc: Ellis, John; Karp, Jeffrey M.
Subject: FW: Final Grenada Manufacturing LLC--Revised IM Work Plan for Vapor Intrusion Study

Pressley, Miriam

From: Bastek, Brian
Sent: Monday, August 31, 2015 6:52 AM
To: Anderson, Meredith; Brian Holtzclaw
Subject: FW: Final Grenada Manufacturing LLC--Revised IM Work Plan for Vapor Intrusion Study
Attachments: 1-dw-Interim Measures Work Plan_Revised 08282015.pdf; Revised Interim Measures Work Plan Cover Letter 8-28-15.docx

Brian Bastek
Environmental Engineer
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Cc: Ellis, John; Karp, Jeffrey M.
Subject: FW: Final Grenada Manufacturing LLC--Revised IM Work Plan for Vapor Intrusion Study

Pressley, Miriam

From: Bastek, Brian
Sent: Thursday, August 27, 2015 1:09 PM
To: Bentkowski, Ben
Subject: FW: Grenada Manufacturing

Ben,

If you can this afternoon, Rob would like to speak with you regarding the inclusion of benzene and xylene in the list of analytes. I can be on the call as well if you like.

Brian Bastek
Environmental Engineer
U.S. EPA, Region 4
RCRA Corrective Action and Permitting Section
Resource Conservation and Restoration Division
61 Forsyth Street, SW
Atlanta, GA 30303
404-562-8511
bastek.brian@epa.gov

From: Uppencamp, Robert [<mailto:Robert.Uppencamp@arcadis-us.com>]
Sent: Wednesday, August 26, 2015 12:13 PM
To: Bastek, Brian; Ellis, John
Subject: RE: Grenada Manufacturing

Feel free to provide Ben with my contact information (below) for him to call me at his convenience.

Thanks,

Rob Uppencamp | Senior Scientist / Risk Assessor | robert.uppencamp@arcadis-us.com

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Please consider the environment before printing this email.

From: Bastek, Brian [<mailto:Bastek.Brian@epa.gov>]
Sent: Wednesday, August 26, 2015 11:50 AM
To: Ellis, John <John.Ellis@arcadis-us.com>
Cc: Uppencamp, Robert <Robert.Uppencamp@arcadis-us.com>
Subject: RE: Grenada Manufacturing

Working on the map. Ben is out, but maybe he can speak with Rob tomorrow morning. I'll call you a little later to discuss both items.

Brian Bastek
Environmental Engineer
U.S. EPA, Region 4
RCRA Corrective Action and Permitting Section
Resource Conservation and Restoration Division
61 Forsyth Street, SW
Atlanta, GA 30303
404-562-8511
bastek.brian@epa.gov

From: Ellis, John [<mailto:John.Ellis@arcadis-us.com>]
Sent: Wednesday, August 26, 2015 11:02 AM
To: Bastek, Brian
Cc: Uppencamp, Robert
Subject: Grenada Manufacturing

Hey Brian,

Have you been able to contact Ben or someone else about the analyte list? I have copied Rob on this email so we hopefully arrange a quick call today to discuss.

Also, any luck on a map?

Thanks,
john

John Ellis, P.G. | Principal Scientist / Geologist | john.ellis@arcadis-us.com

6767
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404-562-8511
bastek.brian@epa.gov

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Sent: Wednesday, August 26, 2015 12:13 PM
To: Bastek, Brian; Ellis, John
Subject: RE: Grenada Manufacturing

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Thanks,

Rob Uppencamp | Senior Scientist / Risk Assessor | robert.uppencamp@arcadis-us.com

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Sent: Wednesday, August 26, 2015 11:50 AM
To: Ellis, John <John.Ellis@arcadis-us.com>
Cc: Uppencamp, Robert <Robert.Uppencamp@arcadis-us.com>
Subject: RE: Grenada Manufacturing

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RCRA Corrective Action and Permitting Section
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Cc: Uppencamp, Robert
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Also, any luck on a map?

Thanks,
john

John Ellis, P.G. | Principal Scientist / Geologist | john.ellis@arcadis-us.com

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Pressley, Miriam

From: Bastek, Brian
Sent: Wednesday, August 26, 2015 12:34 PM
To: Ellis, John
Subject: RE: Grenada Manufacturing
Attachments: Eastern Heights Map.pptx

Let's start with this map.

Brian Bastek
Environmental Engineer
U.S. EPA, Region 4
RCRA Corrective Action and Permitting Section
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61 Forsyth Street, SW
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404-562-8511
bastek.brian@epa.gov

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To: Bastek, Brian
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Subject: Grenada Manufacturing

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